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Agents of Change: Hennebique, Mouchel and ferro-concrete in Britain, 1897–1908*

PATRICIA CUSACK

This paper discusses some of the circumstances of the introduction and establishment of reinforced-concrete framing in Britain [1]. Reinforced concrete existed by the early 1900s as a collection of patented, and a few unpatented, 'systems', with varying dispositions of reinforcement; some systems were designed only for specific structural elements, such as floors or pipes, while others were adapted, not always appropriately, to entire building frames. These systems were commercially exploited by their patentees, but technical details were guarded from public knowledge and protected by vigorous litigation. In 1904, there were over 50 such systems [2]. Among the most flexible and the most widely used was François Hennebique's system, developed in Belgium and France and extended world-wide through a specialist commercial and technical organisation, which was in turn imitated by other major system specialists such as Coignet [3].

The introduction of reinforced-concrete framing in Britain at the turn of the century was a result of Hennebique's business policy of international expansion. Existing commercial exchanges between Nantes, where Hennebique had an agent, and Swansea, may have facilitated the contacts which led to the commissioning and erection in 1897 of the first fully framed and entirely reinforced-concrete building in Britain, Weaver & Co.'s provender mill in Swansea [4]. During the construction of the mill Hennebique selected a General Agent for his system in Britain, L. G. Mouchel, whose work, until his death in 1908, effectively established reinforced concrete in Britain and especially its use for framed buildings, albeit as a private, commercial product.

This commercial aspect, also the existence of competing methods and self-interest, prompted architects and others to start investigations into reinforced concrete, to broaden professional interests in it and to end the specialists' monopoly [5].

Reinforced Concrete at the Turn of the Century

By the mid-1890s, a number of companies and individuals in Britain were employing reinforced concrete (some since at least the 1860s), but primarily for floors, roofs and beams and probably not for framed construction. Some of these companies, including W. B. Wilkinson & Co., the pioneer patentees of reinforced concrete (1854–55),

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continued to design and build in reinforced concrete into the 1900s, but, again, not using complete building frames.

There have been many claims for early designs for reinforced concrete during the nineteenth century, of which only a few are justified; on the other hand, some experiments with reinforcement in Britain have remained little known, such as those by Stuart's Granolithic Co. of Edinburgh in the early 1890s. While W. B. Wilkinson's Newcastle patent of the 1850s remains the earliest ascertained invention of reinforced concrete in the UK, and perhaps anywhere, T. F. Tyerman in Middlesex may have been studying reinforced concrete at the same time, and he filed a patent for bonding metal in concrete before this was included in Wilkinson's own patent. Subsequent inventions in Britain did not improve substantially on Wilkinson's until the early 1890s, with the addition of shear reinforcement in beams, patented in Britain by François Hennebique in 1892.

Throughout the latter nineteenth century in Britain reinforced concrete was not fully distinguished from other combinations of concrete and metal, being advertised under vague descriptions such as F. G. Edwards's 'Fireproof Steel and Concrete' [6]. However, there is some indication that it was becoming fairly widely acknowledged by the time that Hennebique's system was introduced, even if accompanied by considerable scepticism; F. T. Reade for instance in a discussion at the Royal Institute of British Architects in 1907 questioned the sanity of any engineer using reinforced concrete for girders or columns because of the heterogeneity of concrete and steel [7].

The first documented case of the use of Hennebique's reinforced-concrete system in the UK was Weaver's Mill, Swansea, in 1897, the year in which he took out his main British patent. Several other systems applicable to framed-building construction were introduced in Britain during the early 1900s, although the first framed building not in Hennebique's system was probably not until 1905 (using Coignet's system). Systems by Coignet, Considère and Visintini were patented by 1904; by 1907 two further framing systems had been introduced and applied in Britain, one American (Kahn's) and one British (Wells's). Visintini's system acquired a London representative but failed a test by the British Fire Prevention Committee and no framed buildings using it in Britain in this period are known. Documented examples of 'Coignet' framed buildings in Britain prior to 1908 amount to about a dozen (compared to 130 by Mouchel). E. P. Wells, described in 1908 as "one of the few British designers in reinforced concrete" [8], varied his method with circumstances to the extent that he was sometimes said not to have a 'system', but a reinforced-concrete chocolate factory in Portobello, Scotland, was said in 1908 to be "an excellent example of Mr E. P. Wells's system of reinforced concrete construction" [9]. The first major use of Kahn's system was for the headquarters of the Young Men's Christian Association in Manchester (1908), while the first Considère building was not until 1909. Nonetheless, Considère's system had already become a focus for critics of Hennebique's system in Britain, provoking the disparaging comment from Mouchel in 1904 that Considère's method, which employed spiral binding in columns, must "compel us to rob ... the spring mattress industry of its skilled hands" [10].

Hennebique and Mouchel

Hennebique's contribution to both the development and the propagation of reinforced concrete was considerable. He was the first to make systematic provision for shear reinforcement in beams and to use reinforced concrete in monolithic frameworks. His contribution to the marketing of reinforced concrete was spectacular and in Britain as elsewhere in the early 1900s his system predominated over others, due as much to the organisation of his company as to the intrinsic merits of his system. After superintending his own early works in reinforced concrete, Hennebique established commercial arrangements to ensure the controlled employment of his system, with special training courses for his engineers and selected contractors 'licensed' to use his system in return for royalties.

Between 1892 and 1897, when Hennebique introduced reinforced concrete in Britain, his commercial organisation for reinforced concrete expanded from one technical office, two engineers/draughtsmen (and no licensed contractors yet) to 17 offices, employing 56 engineers and draughtsmen, with 55 licensed contractors. By 1909, there were 62 offices, located in Europe (43), the USA (12), Asia (four) and Africa (three), and Hennebique's system was by far the most popular reinforced-concrete method. By mid-1911 there was a total of nearly 24,000 works executed in Hennebique's system, of which 1073 were in the UK [11].

The uncertainty of knowledge and practice in reinforced-concrete work at this time makes the successful erection of so many large reinforced concrete structures in Hennebique's system remarkable: it seems that Hennebique, and Mouchel too, proceeded empirically, employing a large excess of strength [12] and testing every structure as built.

Among Hennebique's successful early framed structures were a factory in St Michel, Switzerland, and another in Cairo (1895), as well as works in northern France. The commission for Weaver's Mill, Swansea, was obtained for Hennebique in 1897 by his agent in Nantes. Particular care was taken in the design and construction of this mill, which was seen as a preliminary advertisement for the use of Hennebique's system in Britain. The working drawings were executed in Hennebique's office in Nantes; the sand and steel were transported from Nantes (although this was quite an economical matter since coal barges leaving Swansea required ballast on the return journey), and trained French workmen were brought over to help with the construction.

One of the factors in Hennebique's commercial success was his careful choice of agents to head his regional and international offices. As a matter of policy, he accorded the agents a large degree of autonomy. Following initial training and practical support, agents like Mouchel became largely independent of Hennebique, though continuing to pay royalties for the use of the system. Mouchel's organisation, established from 1897, was modelled on Hennebique's in both its structure and its expansionist, entrepreneurial philosophy. Regional engineers were trained, like Mouchel himself, in Hennebique's offices in Brussels or Paris. As Hennebique's agent between 1897–98 and 1908, Mouchel was the central figure, both in the application of reinforced concrete in Britain and in its use for framed buildings.

Mouchel had moved from his home town of Cherbourg to Briton Ferry in South Wales many years previously to work as a mining engineer. At this time, there was a lively coal trade between France and South Wales and Mouchel initiated a number of business enterprises mostly connected with this trade. He became a director of various companies, French Consular Agent for several South Wales ports and an Advisor on Foreign Trade for France. When Mouchel became Hennebique's agent, he was a prospering and well-known businessman in Briton Ferry and district.

Thus there does not appear to be evidence for later claims that Mouchel had been either "Hennebique's partner in France" (Morton Shand, 1932) [13] or one of

Hennebique's "senior engineers" prior to 1895 (Collins, 1959), or that "Hennebique sent Louis-Gustave Mouchel... to Britain in 1895, when he landed at Briton Ferry in South Wales, and immediately proceeded to spread the gospel by erecting Messrs. Weaver's Granary and Flour Mill at Swansea" (Collins, 1959) [14].

Certainly, Mouchel became closely involved in the scheme for Weaver's Mill, since he accompanied one of the directors of Weaver & Co. to France in 1897 to see examples of ferro-concrete construction before the contract for the mill was signed. According to one of Mouchel's former engineers, C. Roch, in 1958, it was while Hennebique was arranging the transport of materials for Weaver's Mill that Hennebique and Mouchel first met, through Mouchel's office as French Vice-Consul [15]. Mouchel's interest in the possibilities of ferro-concrete may have predated Weaver's Mill, however. Hennebique's grandson, Robert Flament-Hennebique, believed that Mouchel himself was Hennebique's first client in Britain [16], and an early short biography (1912) of Mouchel refers to (unspecified) ferro-concrete work, perhaps an extension to his business premises at Briton Ferry [17].

Mouchel's business flair and contacts, as well as his engineering background, made him eligible for Hennebique's agency. He was also a man of personal charm and organisational skill. Mouchel had become Hennebique's 'General Agent' for the UK by 1898. Although Mouchel maintained his commercial offices in Briton Ferry, at least initially, he decided at about this time to make the introduction of Hennebique's system into Britain the "chief object of his professional life" [18].

At the start of his agency, Mouchel coined the term 'ferro-concrete' to describe Hennebique's system in English and set about establishing technical offices for the structural design of reinforced concrete works, although the agreed terms were that Hennebique would provide all working drawings initially. Hennebique helped Mouchel in other ways. Mouchel's engineers either came from Hennebique's offices or attended training courses with Hennebique. Mouchel himself underwent several courses of training at Hennebique's Paris office from about 1899 and subsequently drawings were executed usually by Mouchel, or by other French engineers in Britain trained by Hennebique. Mouchel himself began to patent reinforced-concrete designs which extended Hennebique's system; half of these were for piles, perhaps following a personal interest in underground and underwater construction. Roch in 1958 said that he, Roch, drew up the first projects and working drawings in Britain for ferro-concrete works, which included silos at Birkenhead and a warehouse at Brentford (both of 1899).

Encouraged by Roch, Mouchel moved to London in March 1900, initially to a new but bare apartment lacking either WC or lift (an oversight by the architect), but then to 38 Victoria Street, Westminster, which remained the head office. By 1902, Mouchel had opened offices in Manchester and Southampton and had licensed contractors in a dozen cities in England and Wales. By the end of 1904, further offices had been established in Birmingham, Glasgow and Newcastle-upon-Tyne. British engineers and trainees joined Mouchel's company, including J. S. E. de Vesian who with one of his French engineers, T. J. Gueritte, became Mouchel's partners in 1907.

As well as establishing offices, Mouchel tried to create wider professional and public interest in Hennebique's system by inviting groups of architects, engineers and journalists to observe tests of works, by publishing brochures and by lecturing to professional bodies.

Like Hennebique, Mouchel granted licences to building contractors wishing to employ Hennebique's system. Under the licence, Mouchel received royalties of 12 per cent in return for the provision of working drawings; it was also stipulated that the licensee should not use any system except Hennebique's and should inform the licensor of any infringement of Hennebique's patents. Mouchel licensed building contractors both in the UK and, as a British colony, in Australia.

It was Hennebique's policy to select the most competent contractors as licensees and to ensure they were trained in ferro-concrete construction. However, Mouchel did not limit his licences to established contractors, although he is usually thought to have done so. Nor did he believe that ferro-concrete construction required much training, since workmen of average intelligence could be trained "in a very few days—I was going to say hours... no skill and no mental effort is required" [19]. The brief training given to Mouchel's contractors was sometimes complemented by the use of specially trained French workers, possibly at Hennebique's instigation. Furthermore, Mouchel or Gueritte normally supervised buildings personally, together with the architect or engineer and the contractor's representative.

Mouchel's licensees included a firm of machinery manufacturers, Rose, Downs & Thompson of Hull, who wished to build their own factory extension (1900) and subsequently built a public bridge in Hull, both still in use quite recently (Fig. 1). One of the more prolific contractors was the Yorkshire Hennebique Contracting Co. Ltd., who built a particularly interesting work, the eight-storey, entirely ferro-concrete Lion Chambers in Glasgow, as well as a modern-looking office and pattern shop (1908) in Manchester, both still in use (Fig. 2) [20]. Some of the licensees, such as John Aird & Co. and W. Cubitt & Co., were well-known building contractors.

Cubitt themselves experimented with reinforced concrete. In 1903 they constructed a column on Considère's system for tests by the architect William Dunn and in 1905 they constructed beams reinforced in various ways. In order to 'clarify' the meaning of their Hennebique licence, Cubitt & Co. in 1906 used another system for a small piece of reinforced-concrete work at Whitbread's Brewery, London. Mouchel prosecuted them and won the case, thus successfully preventing licensees from working with systems that competed with Hennebique's. Cubitt's was not an isolated move against the licensing system at this time. Neither was Mouchel's action untypical. In the same year he prosecuted Coignet and his representatives for allegedly infringing Hennebique's patent in constructing ferro-concrete piles in Bristol, thereby initiating a long legal dispute. Although Roch (1958) took a cynical view—that Mouchel anticipated a long lawsuit, while his own piles would enjoy a profitable monopoly—it is more likely that Mouchel's defensiveness arose from his initial struggles in introducing Hennebique's system [21].

The Adoption of Ferro-Concrete

According to L. G. Mouchel & Partners' company records (which may have been begun systematically only after Mouchel's move to London (March 1900), or even later, when L. G. Mouchel & Partners was formed), the first executed Hennebique work in Britain was Weaver & Co.'s provender mill in Swansea, listed as Mouchel's fifth UK project [22]. Between 1897 and 1899 there were only about seven Hennebique framed buildings commissioned in Britain, but by 1908 this had risen to nearly 40 new buildings commissioned or under construction in this year alone. Between 1897–1908 over 130 reinforced-concrete framed buildings in Hennebique's system were built in Britain (Fig. 3) [23]. There were roughly the same number again of contracts for parts of buildings, such as floors, with 89 bridges and a similar number

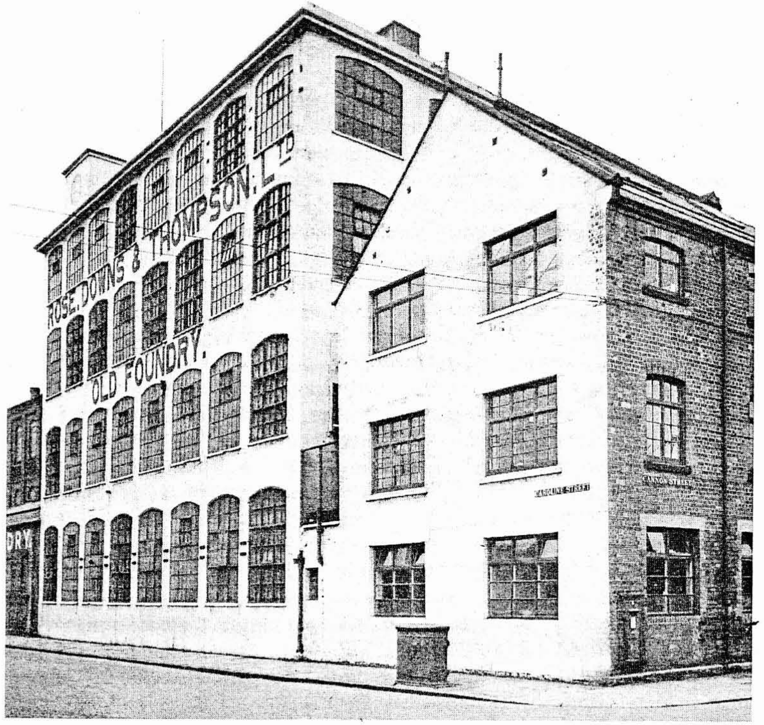

FIG. 1. Rose, Downs & Thompson, Old Foundry, Hull (1900–01). Hennebique system. Contractor: Rose, Downs & Thompson Ltd (photograph reproduced by kind permission of Simon-Rosedowns).

of reservoirs, tanks and marine and river structures, and some colliery works. In 1909, of about 1000 total reinforced-concrete works in the UK, 700 were in Hennebique's system [24]. Despite Mouchel's somewhat liberal selection of licensees, there do not seem to have been any serious failures with reinforced concrete during his agency, apart from a test failure pending a large contract in Manchester, in 1902, which upset Mouchel but did not prevent him securing the contract.

Contradictory opinions have been expressed about the influence of building regulations on the adoption of reinforced concrete in Britain [25]. Insofar as reinforced concrete was adopted less speedily in Britain than in some European countries, factors other than the provisions of building regulations—such as a distrust of reinforced concrete—were probably more significant, except possibly in London. In 1904 Mouchel characterised London as "the only town in the civilised world where ferro-concrete constructions are actually prohibited" [26]; certainly very little visible reinforced concrete was allowed there. Generally, urban building regulations excluded the use of panel walls, whether with reinforced concrete or steel framing. However,

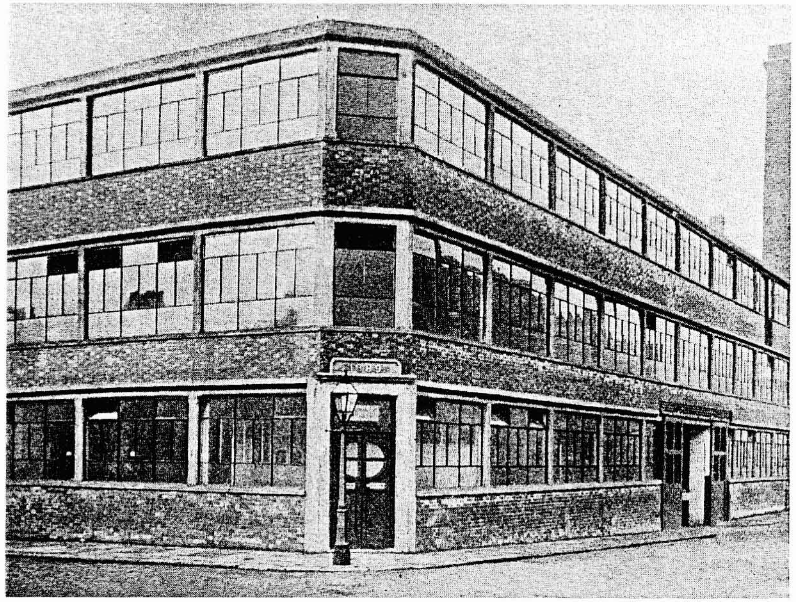

FIG. 2. Unbreakable Pulley & Mill Gearing Co, Office and Pattern Shop. Manchester (1908). Hennebique system. Contractor: the Yorkshire Hennebique Contracting Co. Ltd.

government buildings and those on railway and docklands were usually exempt from such regulations, while restrictions in rural areas were minimal; furthermore some urban councils such as Newcastle Corporation (but not the London County Council) were willing to waive by-laws for reinforced-concrete buildings.

From about 1903, there was increasing criticism from architects and engineers of the lack of legal provision for the use of frames of reinforced concrete and steel, and especially for the use of panel walls. Following the report of the RIBA Joint Committee on Reinforced Concrete in 1907 and the successful construction of some large reinforced-concrete government buildings in London, from about 1908 more local authorities, including the LCC, began to permit reinforced-concrete framed buildings with reduced wall thicknesses and started the slow process of changing their building regulations in favour of such construction.

The main practical advantages claimed for reinforced concrete by Mouchel and other specialists were fire resistance, imperishability, strength and monolithicism. The chief motives for its use (usually in preference to steel framing) were slightly different: fire resistance; economy of cost and space for heavy-duty structures; and in some cases its superior structural adaptability, relative freedom from vibration and salubrity for food factories. Flexible planning and daylighting were scarcely considered, by either specialists or clients (Fig. 4). The economic advantages of reinforced concrete were greatest in large, heavily-loaded plain buildings, such as warehouses and granaries (where fire-resistance was also a consideration) and in Britain these were the main kinds of buildings erected both by Mouchel and by other specialists. The major

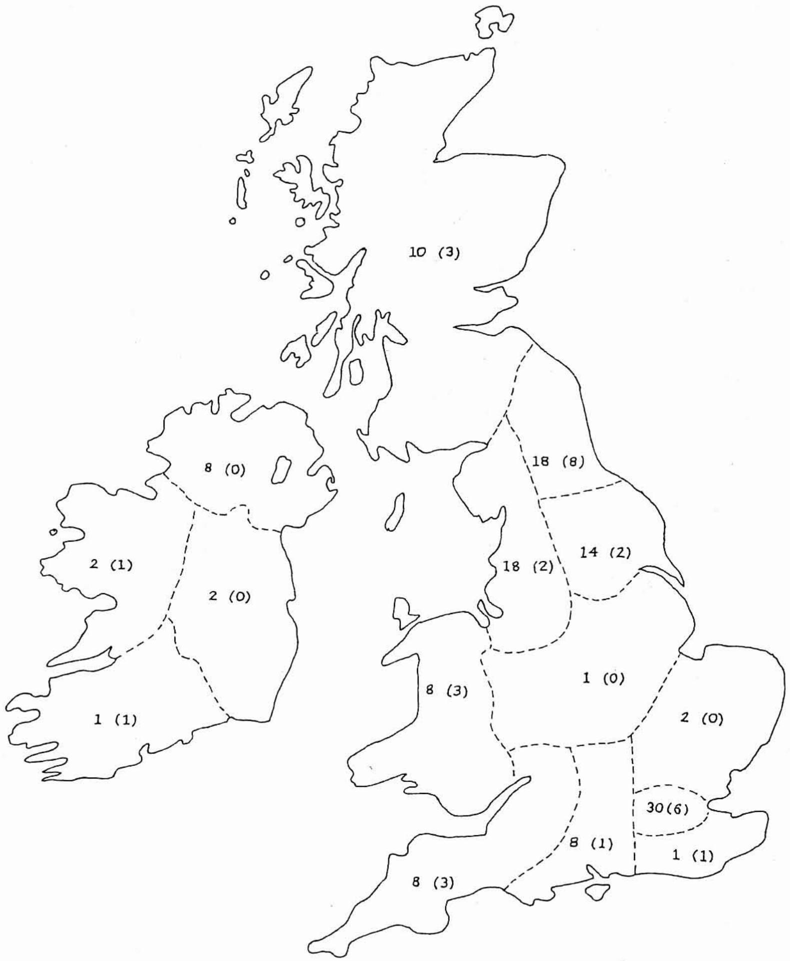

FIG. 3. Geographical distribution of Hennebique framed buildings in Britain 1897–1908. The first figure gives the estimated total number in each region; the bracketed figure gives the number with reinforced-concrete panel walls.

clients for reinforced concrete framed buildings in the UK between 1897 and 1908 can be roughly divided into four groups. In the order of quantity of reinforced-concrete buildings there were:

(1) miscellaneous industrial and commercial companies;
(2) co-operative societies;
(3) railway companies;
(4) grain companies, excluding the Co-operative Wholesale Society.

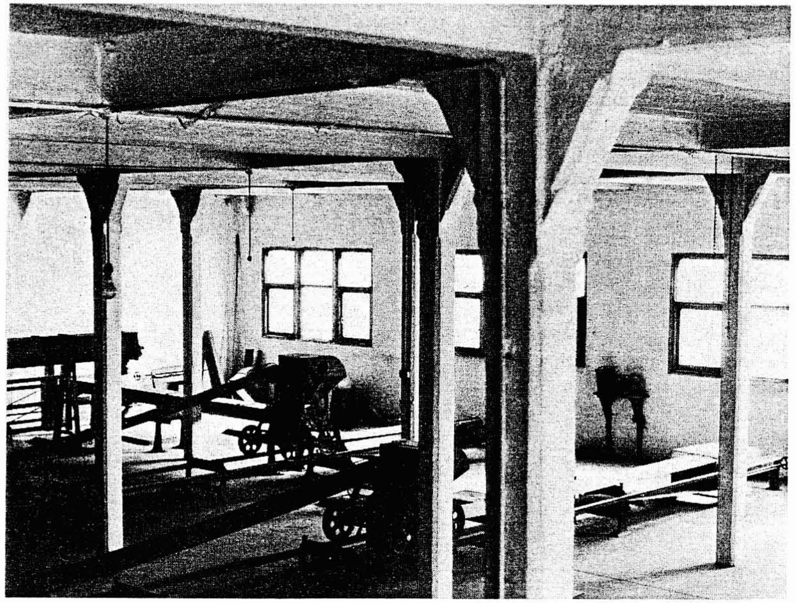

FIG. 4. Co-operative Wholesale Society Ltd, Grain Cleaning House, Dunston on Tyne (1901–02) (demolished). Hennebique system. Architect: F. E. L. Harris, ARIBA.

However, if clients adopted reinforced concrete for practical reasons, they were also influenced by progressive 'modern' interests. Weaver & Co. were noted for their enterprise and modernity. William Weaver had been chosen as Managing Director because he suited the company's requirement for a 'scientific miller': he had obtained the "Gold and Silver Medals for Scientific Milling, the highest distinction obtainable in practical modern Milling" [27]. The Co-operative Societies represented a radical tradition of organising commerce and the CWS, who built the Quayside Warehouse, Newcastle, in 1899 and the silos at Dunston in 1901, had a chairman known for his wide interests—"social, scientific and intellectual" [28]. John Buchanan & Bros. Ltd, Confectioners, of Glasgow, who used Hennebique's system for their buildings from 1907, again had a reputation for enterprise and the use of modern facilities in production; their works (1901) displayed a "pantomime of machinery" [29]. The works of Alley & MacLellan Ltd, builders of "portable ships", who in 1905 erected a four-storeyed pattern shop in ferro-concrete in Glasgow, were said to exhibit "originality and energy" (for instance, making use of light railways to convey products between departments) [30]. Other clients too, whether large concerns such as the North Eastern Railway Co. or smaller firms like the Unbreakable Pulley & Mill Gearing Co. Ltd of Manchester, showed a similar 'innovative' tendency remarked upon by contemporary observers.

Although the majority of these reinforced concrete works were commercial and industrial structures and although in this period architects were engaged for only 10 per cent of all buildings, architects were frequently employed along with reinforced-concrete specialists on the early buildings [31]. Architects designed these buildings in detail, then the specialist adapted reinforced concrete to the architect's design, providing all structural details. The results, although perhaps predictable, evidence the dominance of style over material. Since at this time architects, as well as engineers, were usually uninformed about reinforced concrete, the early buildings were designed as if for traditional materials; however, they also tended to conform to a contemporary—and inappropriate—preference for 'Renaissance' styling. The 'thinness' and 'flatness' of reinforced concrete construction had somehow to be given, as Sir Aston Webb put it in 1911, "that architectural character of solidity and permanence without which no architecture can be satisfactory to the eye" [32]. Architects who for reasons of economy used reinforced concrete for the external walls as well as the frame of their buildings tried to give their elevations an identifiable architectural character and to counteract the problematic 'flatness' by means of classical articulation and details imitating stone construction (Figs. 5 and 6). Some of the early buildings were designed in a more functional tradition;-for example, Weaver's Mill or Rose, Downs & Thompson's workshop in Hull, on both of which an architect was employed. One distinctive early building entirely in Hennebique's system, the Lion Chambers, Hope Street, Glasgow (designed by the architects J. G. Gillespie and James Salmon) managed to incorporate the characteristic lightness and flatness of reinforced concrete in a hybrid design drawing on Arts and Crafts ideas and related to contemporary Glasgow *Art nouveau* [33]. Another idiosyncratic example was Lynn House, West Hartlepool, designed and built around a Coignet frame in 1906–07 (Fig. 7).

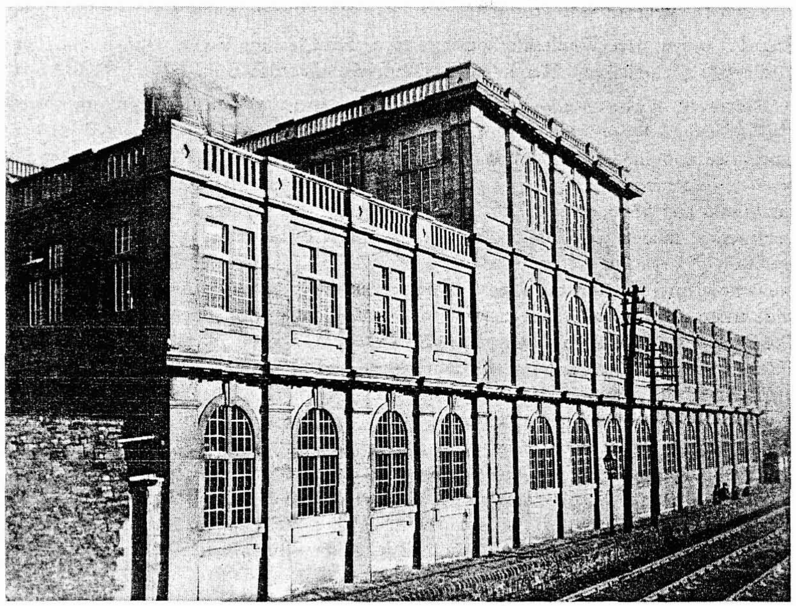

FIG. 5. Co-operative Wholesale Society Ltd, Soap Factory, Dunston on Tyne (1907–09). Hennebique system. Architect: L. G. Elkins, ARIBA.

FIG. 6. Jarrow & Hebburn Co-operative Society Ltd, Drapery Depot, Jarrow (1904). Hennebique system. Architect: J. Cordiner. (Photographed 1977).

Perhaps because of their initial involvement in the design of reinforced concrete buildings, it was architects rather than engineers who first began to question the conditions of reinforced-concrete practice and to criticise the specialists for their monopoly and 'trade secrecy'. (It must be said that some of the criticism levelled at Mouchel was jingoistic.) There was little interchange of experience among specialists, whilst general knowledge about reinforced concrete was seen to be restricted. Consequently, the RIBA established a committee in 1906 to examine and report on reinforced concrete for the benefit of architects; this was accompanied by the launch of a new journal for further debate and publicity and followed in July 1908 by the founding of the Concrete Institute [34].

The main outcome of this activity, apart from provoking the Institution of Civil Engineers into taking a belated interest in reinforced concrete and setting up its own Committee (December 1908), may have been to encourage universities and other educational bodies to take up the subject of reinforced concrete and so continue the process of making the new material more widely accessible.

Conclusion

Mouchel's establishment of Hennebique's system and its application for framed buildings in Britain led to the erection of many Hennebique works all over the UK in this period. The growing awareness of reinforced concrete was indicated by the criticisms levelled at Mouchel for his monopoly of reinforced concrete and by

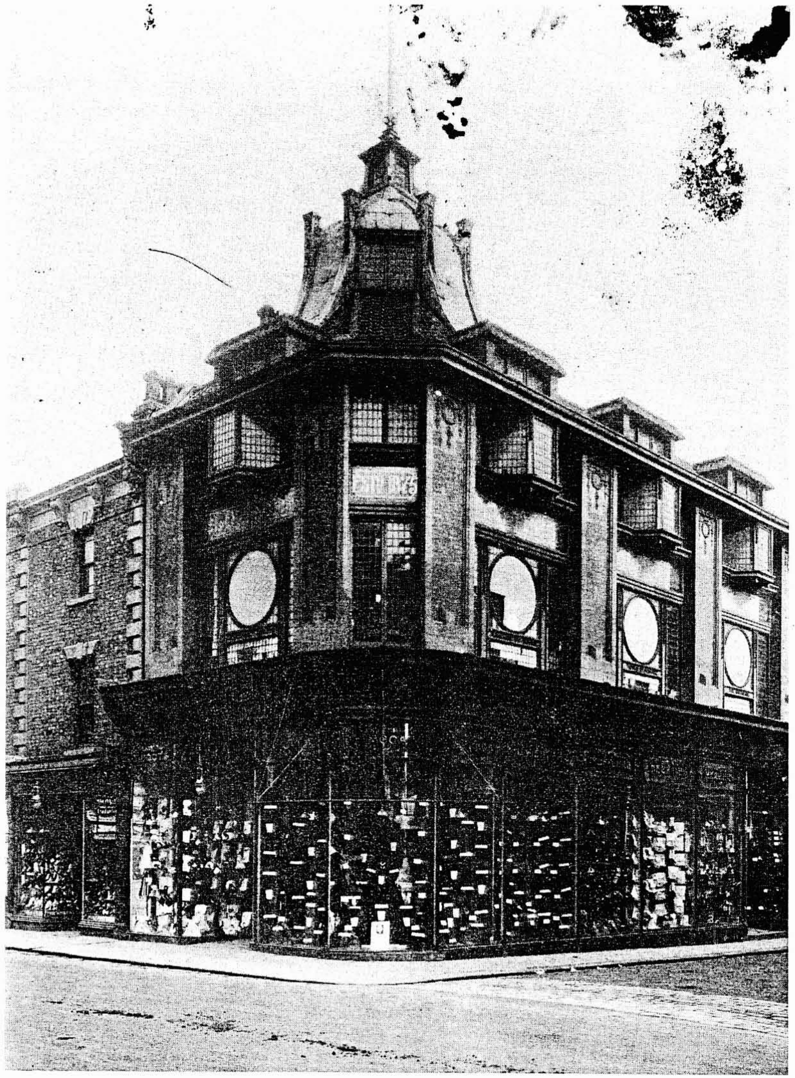

FIG. 7. M. Robinson & Sons Ltd, Lynn House, West Hartlepool (1906–07) (demolished). Coignet system. Contractor: Watt Bros. Architects: Harry Barnes, ARIBA and Charles F. Burton.

architects' demands for access to what was increasingly recognised as a viable 'new' building material, with definite practical advantages.

The terms of this access were seen to be the freeing of reinforced concrete from

patentees' control of its design and execution, as well as the alteration of building regulations to encourage the use of reinforced concrete framing.

The secrecy surrounding the techniques of reinforced concrete obviously restricted opportunities for criticism and correction, and the RIBA Committee and similar initiatives were attempts to open up the subject for study and debate. Yet it is arguable that the conditions of the early employment of reinforced concrete in Britain, largely by Mouchel's company, together with Mouchel's personal dedication to the work, ensured that in a period of rudimentary knowledge about reinforced concrete, Hennebique design and construction was able to work successfully.

The buildings extant from Mouchel's period are in general sound but neglected. Recently several have been demolished for commercial reasons; the former site of Weaver's Mill is now a car park for Sainsbury's. Yet there still exist examples of the mixed results of architects' first encounters with the material in Britain. Architects and their clients are likely to have been working somewhat in the dark, although the architect and client for Weaver's Mill at least had seen Hennebique's mills in northern France. Weaver's Mill and other "functional" examples may well have represented attempts to appear scientifically up-to-date, like the companies they housed. Elsewhere, although there were exceptions drawing upon Arts and Crafts ideas, the predominant architectural symbolism of substance, permanence and classical reference was now cast in reinforced concrete.

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[1] The paper is based on material from: P. Cusack, 'Reinforced Concrete in Britain: 1897–1908' (unpublished Ph.D. thesis, University of Edinburgh, 1981). Published articles by the writer which expand some of the themes here are indicated below where relevant. 'Ferro-concrete' was the name given to Hennebique's reinforced concrete system in Britain by Mouchel.

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[15] Mouchel Papers (West Byfleet), letter of C. Roch to C. R. J. Wood, 5 June 1958 (transl. 15 October 1959), p. 6.
[16] Robert Flament-Hennebique, letter to Patricia Cusack, 2 August 1980.
[17] 'The Life and Work of Louis Gustave Mouchel', *Ferro-Concrete*, 3 no. 7 (1912), p. 212.
[18] Ibid., p. 212.
[19] L. G. Mouchel, 'Monolithic Constructions in Hennebique's Ferro-Concrete', *Jnl R.I.B.A.*, 12 (1904), p. 50; L. G. Mouchel, *The Hennebique Ferro-Concrete System* (2nd edn, 1905), p. 20.
[20] Lion Chambers is discussed and illustrated in P. Cusack, 'Lion Chambers: a Glasgow Experiment', *Architectural History*, 28 (1985), pp. 198–206.
[21] Manchester Ship Canal Co. Papers, letter of L. G. Mouchel to W. Henry Hunter, 5 September 1902.
[22] L. G. Mouchel & Partners Ltd. (38 Victoria Street, Westminster), *Project Record No. 1 (Nos. 1–8750)*.
[23] L. G. Mouchel & Partners Ltd., *Mouchel-Hennebique Ferro-Concrete. List of Works Executed in the U.K. 1897–1919*, (n.d., c.1920). Also personal inspection of many individual buildings by the author.
[24] 'British Engineers and Ferro-Concrete', *Ferro-Concrete*, 1 no. 4 (October, 1909), p. 65.
[25] P. Collins, *Concrete*, p. 78; Marian Bowley, *The British Building Industry* (Cambridge, 1966), pp. 12–13, 26.
[26] 'Monolithic Constructions', p. 60.
[27] Cusack, 'Weaver's Provender Mill and Silos', p. 6.
[28] *C.W.S. Annual* (1916), preface.
[29] W. S. Murphy, *Captains of Industry* (Glasgow, 1901), p. 200.
[30] Ibid., pp. 123–124 and 126.
[31] R. Norman Shaw & T. G. Jackson, eds. *Architecture: A Profession or an Art* (1892), p. xv; *Jnl R.I.B.A.*, 12 (25 Feb 1905), p. 249 (T. G. Jackson).
[32] Sir Aston Webb, 'Discussion of Sir Henry Tanner's Paper', *Jnl R.I.B.A.*, 18 (January 1911), p. 171.
[33] See Cusack, 'Lion Chambers'.
[34] See Cusack, 'Architects and the Reinforced Concrete Specialist'.

An Unusual Organisation of Production: the building firm of the Perret Brothers, 1897–1954

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Paying homage to Auguste Perret in 1951, Pierre Dalloz (who had spent six years with the Perret firm) recalled the exceptional manner in which production was organised in the firm, uniting on a permanent basis "all who have the capacity of conceiving, of calculating, of evaluating and of carrying out any building". It was said to be "a firm which is patriarchal yet has working rules in the forefront of progress" [1]. Dalloz recalled that there were never more than a dozen collaborators in the organisation, including the old draughtsmen faithful to the firm for 40 years, such as Conchon, Brochard and Meunier, as well as young architects being trained, of whom Le Corbusier (then Charles Edouard Jeanneret) was without doubt the best known [2]. The firm's small size was a good idea: "We do not embrace too much; we do not run the risk, where others have failed, of finishing as business what we had started as architecture". Dalloz insisted on the close relationship between architect, engineer and contractor in an organisation where only projects detailed to the last door knob resulted, which of course considerably facilitated site work. The contractor never outpaced the architect, because in the 'ordered world' of the Perret firm, such a pretension would have been inconceivable: "There, we respected the etymology: the architect is the head of all the technicians. It is he who first had the honour of creating, and then the prerogative of sustaining his creation until the last detail". This harmonious integration of various functions, necessary to the act of building, under the name of the architect was possible because of the family character of the firm.

> Son of a building contractor, himself a contractor, but mainly an architect, Auguste Perret entered this world and was followed by his two brothers Gustave and Claude. I do not know if he appreciated the rarety of this opportunity. The six years during which I worked for the Perret firm . . . I had time to ponder upon the strength involved in this brotherly partnership . . . [3].

A Builder

The Perret firm was before anything else a family business and Dalloz is right to emphasise the fact that in the firm the architect dominated all the functions involved in the process of production. But the term 'architecture' must be understood in a

* Translation by Renée Losier.