Reinforced Concrete Condition Assessment in Architectural Heritage.

The Lion Chambers Chambers (Glasgow, UK) and the Teatro E. Duni (Matera, Italy)
This publication contains the results of the start-up phase of the research undertaken by the Faculty of Engineering - Department of Architecture, Planning and Transport Infrastructures of the University of Basilicata and the School of Built and Natural Environment of Glasgow Caledonian University. The research was funded within the scope of the International Collaboration Project “Call for Ideas” – Internationalisation Programmes – Indicator D.4 Projects aiming to consolidate and/or initiate joint research projects and exchange of students and lecturers (Chapter I.06.41/011 “Co-finance of International Co-operation Programmes” provided from the first Triennial Programme for the Region of Basilicata/University 2007/2009).

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The research undertaken in this study has been initiated following the agreement between Glasgow Caledonian University (GCU) and University of Basilicata (USB) to establish research collaboration. The aim of the collaboration is to use the expertise available at both institutions on a range of research projects in the field of sustainable refurbishment of buildings to assist in decision making for preservation and revitalisation of architectural heritage.

GCU’s researchers have been undertaking research in collaboration with Historic Scotland and with researchers involved in the UK and EU funded projects. GCU is leading CIC (Construction Improvement Club) Start Online (www.cicstart.org), a joint project of seven Scottish universities whose aim is to support collaboration between academia and construction sector to develop and test innovations for sustainable building design, construction and refurbishment. CIC Start Online activities are disseminated online through interactive webinars, video recordings and online conferences.

The researchers at USB carry out research in restoration of built heritage, sustainability of building process, restoration and rehabilitation of historic centres, and refurbishment of the monuments. The research group collaborates with the Soprintendenza per i Beni Architettonici e per il Paesaggio della Basilicata and the Istituto per i Beni Archeologici e Monumentali IBAM/CNR (Potenza) and undertakes test campaigns to learn about technical and environmental qualities of buildings, and to evaluate their environmental impact.
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Preface

by A. Restucci, Chancellor of I.U.A. of Venice, Italy
In the last decades, the architectural heritage of the modern movement seems to be more at risk than during any other period. This built inheritance embodies the dynamic spirit of the industrial age. At the end of the 1980s, many modern masterpieces had already been demolished or changed beyond recognition. This was mainly due to the fact that many were not considered to be elements of heritage, that their original functions have substantially changed and that their technological innovations have not always endured long-term stresses. Recognising this threat, The Twentieth Century Society was founded as the Thirties Society in 1979 in the United Kingdom. “The Society’s prime objectives are conservation, to protect the buildings and design that characterise the Twentieth Century in Britain, and education, to extend our knowledge and appreciation of them, whether iconic buildings like the Royal Festival Hall or everyday artifacts like the red telephone box”¹.

Sustainable preservation and reuse of architectural heritage contribute to the reduction of carbon emissions and more sustainable development of the built environment. If the targets for reduction of carbon emissions are to be achieved, sustainable refurbishment of existing buildings must be undertaken. In Italy, along with the Ministry for Cultural Heritage and Activities, preservation institutions and research centres, the cultural association DO.CO.MO.MO operates since 1995. Its objective is to document and conserve modern buildings and urban areas, to contribute to the evaluation of modern architecture, and to promote its preservation and research on methodologies and appropriate intervention criteria².

A thorough research of built heritage enables understanding of the evolution of design philosophies and underlying cultural meanings and messages, artistic and functional qualities, and engineering achievements. A detailed knowledge of building materials, construction techniques, environmental services (e.g. heating, ventilation, water etc.), external impacts (e.g. weather, pollution, flora and fauna) and internal impacts of use or disuse assist in identifying the problems affecting buildings and defining a methodological approach for sustainable interventions. Sustainable preservation and the reuse of architectural heritage contribute to the reduction of carbon emissions and to a more sustainable development of the built environment. If the targets for reduction of carbon emissions are to be achieved, sustainable refurbishment of existing buildings must be undertaken.

The aim of the research collaboration between Glasgow Caledonian University and the University of Basilicata is to exchange ideas relating to conservation technology and history; to foster interest in the ideas and heritage of the Modern Movement, and to provide documentation in support of conservation of valuable buildings, sites and neighbourhoods of the Modern Movement.

The research objective is to provide new qualitative

information on the strength of reinforced concrete structures of two prominent examples of modern architecture by using innovative, non-invasive testing techniques. The first one is Lion Chambers in Glasgow (Scotland, United Kingdom) designed by the architects Salmon, Son and Gillespie and completed in 1907. The second one is Duni Theatre in Matera (Southern Italy), designed by the architect Ettore Stella and completed in 1949.

The Lion Chambers was the second example of the use of François Hennebique’s reinforced concrete system in a building in Glasgow and one of the earliest in Britain. The confluence of the local architectural styles (vernacular and academic) and the emerging aesthetic of reinforced concrete is explored to outline the context that influenced the building design which led to the direction of the Modern Movement, away from Art Nouveau whose Scottish interpretation gained international recognition in the works of Charles Rennie Mackintosh, a good friend of James Salmon Jr. Aesthetics of the Modern Movement sought to express the physical characteristics of new building materials and to explore how they can be used to develop innovative structures and forms. The Austrian architect Otto Wagner was the first to take a leap from past styles (vernacular or academic) and structural or decorative interpretations of the natural world towards the minimalism of structural needs and exposed materials such as reinforced concrete, different metals and glass in the design of the interior of the Post Office Savings Bank (1904-12) in Vienna.

The Theatre Egidio Romualdo Duni in Matera is an excellent example of early Modern Movement architecture in Italy. The designs of the architect Ettore Stella were influenced by the work of architects such as Giuseppe Terragni (1904-1943), Walter Adolph Gropius (1883-1969), Richard Josef Neutra (1892-1970) and Frank Lloyd Wright (1867-1959). In the years immediately after the Second World War, Stella was a proponent of the revision of the methodology for evaluating the architectural heritage that would include a successful integration of technological innovations. He demonstrated how the inclusion of a building in an urban context is more successful if it is not forced to ‘mimic’ its surroundings even when including architectural elements that directly express manufacturing processes (e.g. through the use of reinforced concrete, high quality arts and crafts etc.).

The research methodology includes (a) the context in which the buildings were designed, (b) their history, (c) building technologies used, (d) non-invasive testing of the reinforced concrete structures, (e) the analysis of the test results and (f) the conclusions.

Testing methods could be “distructive”, as they require a local removal of material, or “non-destructive”, i.e. they do not affect the structure. A sclerometer test, an ultrasonic test and their combined use, called SonReb (SONic+REBound), are “non-destructive” tests on reinforced concrete. The combined tests are a very useful method for assessing the concrete strength and to reduce the possibility of errors that can happen if the tests are not combined, as it has been noticed that the humidity content of a structural element can influence the sclerometer index and the ultrasound speed. The combined method requires shorter time to obtain the results.

The research outcomes are of interest to the architects and engineers operating in the construction sector, researchers in history of architecture and construction, as well as officials of the institutions responsible for conservation of built heritage.

1.1 Early applications of reinforced concrete in “Modern Architecture”: Europe and UK

The philosophy of Modern Architecture can be traced back to the question raised by Claude Perrault (1613-1688) on the validity of the Vitruvian proportions refined through Classical theory.1 Perrault was a French architect and physicist who translated ‘Ten Books on Architecture’, written by Marcus Vitruvius Pollio (c. 80-70 BC – c. 15 AC), and used a Classical order for the design of the Colonnade and east front of the Louvre (1667-1670) in Paris.2 Perrault’s knowledge of Classical and other historical architectural styles enabled him to understand the limitations in their application to utilitarian and other buildings whose function did not require monumental architectural orders or decoration. He proposed two different design approaches – one that has a normative role of standardisation (of historical styles in architecture) and an alternative one that expresses functions as may be required by particular circumstances or character.3 The former was taught from 1671 at the Académie d’architecture, which was merged with the Académie des Beaux-Arts in 1795, and the latter was developed at the École des Ponts et Chaussées from 1747.4

This divide in the teaching of building widened with the emergence of new building materials and construction technologies in the 19th century. Heavy building proportions and intricate decorative elements of historical architectural styles were suitable for stone, but not for iron, steel, reinforced concrete and large glass surfaces whose load bearing properties, textures, colours, physical characteristics and manufacturing processes required different design approaches. However, Jean-Nicolas-Louis Durand (1760-1834) attempted to provide a system for using Classical forms for a range of new buildings in his Précis des leçons données à l’Ecole Polytechnique (1802-09).5

Knowledge on the behaviour of new building materials in different climates and weather conditions, their durability or thermal properties, was not readily available. The use of new building materials and techniques in the 19th century instigated learning through experiments and research on physical properties and behaviour of new building materials within composite building elements, in contact with other materials and within the whole structure. At the same time, the aesthetics of iron, concrete and glass were explored. A departure from historical architectural styles led to a freedom in the design of structural elements, building envelopes, layouts and forms. These experiments in building

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engineering and design laid the foundations for Modern Architecture of the 20th century. Since its development in the 19th century, reinforced concrete has been used for the construction of civil engineering projects and different building types. It is a structural element composed of concrete and iron or steel bars. Cement, aggregates and water are basic components for concrete mixture. The use of monolithic concrete (without iron bars) in Roman architecture and civil engineering structures enabled the construction of wider spans, but the concrete surface was covered with stone or brick. During the reign of Louis XVI (1754-1793), stuccoed rubble was increasingly used with a finish that imitated masonry. The use of timber formwork for moulding mud walls of French rural buildings and the publication on *Experimental Researches into building limes, concretes and ordinary mortar* (1818) by Louis Vicat (1786-1861) inspired the architect François-Martin Lebrun (1799-1849) to build a house at Marssac (1832), near Albi in France, that has walls, floors, external staircase and vaults between the floors of compressed concrete. The use of wrought-iron in building began with masonry reinforcements in French medieval cathedrals, and later in Perrault’s east facade of the Louvre, Jacques-Germain Soufflot’s (1713-1780) portico of St-Genevieve (1772, Panthéon), Victor Louis’ (1731-1800) roof for the Théâtre Français (1786) and the theatre in the Palais-Royal (1790). In Britain, cast-iron beams were used for the first time in Salford Mill, Manchester (1801), designed by English manufacturer Matthew Boulton (1728-1809) and Scottish engineer James Watt (1736-1819). The first building with cast and wrought-iron frames was a four-storey boat store in the Naval Dockyard at Sheerness (1860), designed by Colonel G. T. Green (1807-1896). The first glass barrel vault on cast-iron frames was Pierre Fontaine’s (1762-1853) Galerie d’Orléans, built in the Palais Royal in 1829. Prefabrication of cast-iron systems enabled fast assembly on a building site and transportation of structural elements to locations across the world. Joseph Paxton’s (1803-1865) Crystal Palace (1851) in London, built in four months, demonstrated the speed of the construction process and the emerging aesthetics of iron and glass buildings.

Experiments in combining concrete and iron started in the first half of the 19th century. John Claudius Loudon (1783-1843), a Scottish landscape architect, recommended in his *Encyclopedia of Cottage, Farm and Villa Architecture* (1834) a system of fireproof flooring consisting of a latticework of iron rods embedded in cement. A structural system that combines mass

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10 Frampton, op. cit., p. 30.
11 Ibidem, p. 32.
13 Frampton, op. cit., p. 33.
14 Ibidem.
15 Collins, P., op. cit., p. 29.
concrete and inverted T-section cast iron beams was developed by Henry Hawkes Fox and James Barrett in 1844.16 W.B. Wilkinson, a Newcastle plasterer, took out an English patent in 1854 for embedding in floors or beams of concrete (either arched or flat) a network of flat iron bars.17 François Coignet (1814-1888) commissioned the architect Théodore Lachèz to design a concrete house in French Neo-Classical style with iron beams in its flat roof at St. Denis in Paris in 1853, then took out a patent for monolithic concrete, exhibited at the Universal exhibition of 1855, and boldly declared that the reign of stone in building had come to an end and that cement, concrete and iron were destined to replace it.18 In 1861, Coignet formed the Société Centrale des Bétons Agglomérés and continued experimenting with monolithic concrete on different building types, including a six-storey apartment block in Paris in 1867 designed in the style of Parisian housing architecture.19 The engineer Jean-Charles Adolphe Alphand (1817-1891) designed Parc des Buttes Chaumont in the 19th arrondissement, completed at the opening of the Exposition Universelle in 1867, which showcased advances in industrial materials and innovative building practices and technologies, demonstrating their aesthetic merits.20 Concrete was used for the lining of the lakebed and the hard-edged curb of the lake in the park. Stuc ciment, a relatively loose or wet mix of cement, sand and lime, was artistically applied over a foundation of masonry, rock or concrete. Reinforced concrete was used for architectural features, stairs, handrails and the massive retaining walls lining the railroad embankment next to the park.21 At the 1855 exhibition, Joseph Tall, an English building contractor who developed demountable and reusable shuttering, won a gold medal and was commissioned to build workmen’s dwellings in the Boulevard Daumesnil in Paris.22 Sephard and Newton are also mentioned as contractors of these houses.23 Charles Drake, who had been employed by Tall as his manager, developed a system with metal instead of timber up-rights, and built cottages, villas, churches and halls imitating historic architectural styles from 1868.24 Architect and builder W.H. Lascelles (1832-1885) patented a reinforced pre-cast slab construction in 1875 and collaborated with the architect Richard Norman Shaw (1831-1912) on the design of cottage buildings.25 Engineer Philip Brannon developed patents for monolithic concrete reinforced with iron rods in 1871 and 1874 and built a few large houses, but also contributed to public anxiety towards concrete when his buildings in Islington, London, collapsed owing to faulty construction.26 As the reinforced concrete was

16 Ibidem
18 Ibidem, p. 28, 29.
19 Ibidem, p. 34.
21 Ibidem, p. 9.
22 Collins, P., op. cit., p. 41.
24 Ibidem, p. 42.
25 Ibidem, p. 43.
26 Ibidem, p. 43, 44.
Chapter 1

from Kirkwall to Rome and from Quimper to Constantinople; it would be far better to have the equivalent knowledge of steel and concrete construction. … If I were again learning to be a modern architect, I’d exchange taste and design and all that stuff and learn engineering, with plenty of mathematics and hard building experience. Hardness, facts, experiment - that should be architecture, not taste.”

However, the interest in using reinforced concrete continued in Liverpool; the flats in Eldon Street were built of precast concrete in 1905; and in 1909, the Royal Liver Building in Liverpool, designed by Walter Aubrey Thomas (1859-1934), was built with reinforced concrete frames (Hennebique’s system) behind its monumental, 90m high facades whose design relied on historical architectural forms. François Hennebique (1842-1921) first used pre-cast concrete beams containing cylindrical iron rods in the floors of a house built in 1879. By 1892, British architects and engineers had almost completely lost interest in further development of reinforced concrete on a larger scale, and the lead was taken by the French. One of the reasons for the hesitation in using reinforced concrete was a lack of engineering knowledge in the education of some architects such as the architect William Lethaby (1857-1931), whose competition project for a reinforced concrete Liverpool Cathedral (1902) was not successful, and who wrote:

“It is absurd, for instance, that the writer should have been allowed to study cathedrals

27 Ibidem, p. 52
28 Ibidem, p. 54.
29 Quoted here from Collins, P., op. cit., p. 54.
33 Ibidem, p. op. cit., p. 64.
34 Ibidem, p. 65.
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first reinforced concrete buildings were spinning
mills in France whose exposed frames rhythm-
ically divided facades and enabled the use
of large window surfaces. When the business
expanded, Hennebique commissioned the ar-
chitect Edouard Arnaud (1864-1943) to design
the company headquarters and the flats above
them in rue Danton, Paris, in 1898.
Hennebique demonstrated his openness to the
enquiry of architectural design of reinforced con-
crete by inviting Pascal Forthuny (1872-1962), a
well-known architectural critic, to comment on
the design of the company headquarters. For-
thuny's comments were published in the firm's
magazine in May 1901, thus spreading the
message that could have reached everyone in-
terested in designing with reinforced concrete:

‘… Reinforced concrete is a new material, and
has no links with the systems of construction
that preceded it; it must thus necessarily draw
from within itself its exterior aspects, which
must be clearly differentiated from familiar mo-
tifs in wood, marble or stone.’

Hennebique's system was used in the construc-
tion of theatres in Morges and Berne (Switzer-
land), Münich (Germany) and for the Théâtre
des Champs-Élysées in Paris, designed by Au-
guste Perret (1874-1954) in 1911. By 1902,
Hennebique had more than fifteen hundred
contracts a year with licensed contractors in near-
ly every European country, and by 1917 he
had completed 17,692 building contracts and
a similar number of engineering works. Hen-
nebique participated in drawing up the official
regulations on the use of reinforced concrete,
published in 1906. His important contribu-
tion was in proving that reinforced concrete is
a construction material that can be used safely
and in initiating its use across Europe.
The 1900 Exhibition in Paris, for which many
buildings were designed in reinforced concre-
te, is considered as a principal event that in-
fluenced the adoption of this system in other
European countries. In 1903, the architect
Auguste Perret (1874-1954) used a concrete
frame for a 10-storey block of flats in 25 Rue
Franklin in Paris. Over fifty different reinforced
concrete systems were developed by 1904. How-
ever, François Hennebique's system expan-
ded across Europe due to his organisation of
the business which controlled both design and
construction. Louis Gustave Mouchel became
Hennebique's agent in Britain from 1897-98.
The use of reinforced concrete structures star-
ted in Glasgow in the last decade of the 19th
century. William James Anderson (1863-1900),
who was appointed as Dean of Architecture
at the School of Art in 1894, designed Orient
House at 16 McPhater Street in Cowcaddens
(1892-95). Its Italian Renaissance facades with

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36 Ibidem, p. 70.
37 Ibidem, p. 71.
38 Ibidem, p. 72.
39 Ibidem, p. 75.
40 Ibidem, p. 72.
41 Newby, F., The innovative uses of concrete by engineers and architects, in Sutherland, J., Introduction, in Sutherland, R. J. M., Humm, D.
42 Marsh, C.F., Reinforced Concrete, London, 1904. As quoted in Cusack, P., Architects and the reinforced concrete specialists in Britain
45 Extract from Statutory List, Glasgow City Council, HB number 32754, Category A. Available at www.glasgow.gov.uk, accessed on 23/03/2011.
It was noted that, along with the translation, Charles F. Marsh added a good deal of original investigation in the way of doing calculations for design, together with descriptions of special systems, English and American.\textsuperscript{50} The author praised the most recent extended edition co-authored by Scottish architect and engineer William Dunn (1859-1934)\textsuperscript{51}. Approximately twenty reinforced concrete buildings were completed or begun in Great Britain by 1904, the year when Salmon, Son and Gillespie decided to use reinforced a concrete structure for Lion Chambers.\textsuperscript{52} The building has been recorded in the history of architecture as probably the only non-industrial building constructed before 1910 which did not deliberately disguise its\textsuperscript{53} structure.\textsuperscript{54}

1.2 The search for new aesthetics in architecture in Scotland at the turn of the 20\textsuperscript{th} century

Scotland’s architecture during the 19\textsuperscript{th} century offered a spectrum of historic architectural styles: Gothic revival on churches, neo-Greek and other classical forms on public buildings with the influence of the French Beaux Arts from around 1870, academic baronial (with French or Tudor or Jacobean influences) on the

\textsuperscript{48} Anonymous. Views and Reviews. Reinforced Concrete. The Builders Journal and Architectural Engineer: Concrete and Steel Supplement (Monthly), 30 January 1907
\textsuperscript{49} Ibidem.
\textsuperscript{53} Collins, P., op. cit., p. 82.
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country houses, and some baronial vernacular in urban architecture. The industrial revolution in Western Europe during the 19th century created wealth that was re-invested in new industrial buildings, housing, offices and public buildings. Scotland, and particularly Glasgow, contributed to the industrial growth through engineering innovations, shipbuilding and commercial activities on the river Clyde, and a range of manufacturing businesses. From 1890 to around 1910 Glasgow reached the pinnacle of industrial development and wealth. Between 1900 and 1913, the value of exports from the city increased from £18 m to £33 m.55 Goods and people arrived either through its large harbour or through the Central Station (1879), fronted with a huge Victorian building, designed by the architect Sir Robert Rowand Anderson (1834-1921)56. Glasgow marked its prosperity by building the City Chambers (1890), another grand building with opulent and high quality interior finishes, designed by William Young (1843-1900)57. The city had strong business links with the USA and Europe that enabled the flow of new technological knowledge.

Judging by the amount, range and quality of buildings of late Victorian Glasgow, it was a good place for a young architect as Glasgow's institutions, businesses and developers invested in architecture.58 The contemporary experiments in architectural design in Glasgow have produced a range of buildings whose designs do not completely fit into any historical style, but represent a free combination of compositions, forms and decorative elements from different styles. These experiments became known as ‘Glasgow Free Style’.59 Freedom of design was also expressed in different approaches to the composition of building facades and their finishes, an example being the School of Art, designed by Charles Rennie Mackintosh (1868-1928) in Art Nouveau style that included elements of Scottish architectural tradition. The Glasgow Free Style’s search for new forms in architecture, as in other similar movements in Europe and the USA at that time, was a reaction to more than a century of architectural historicism. As interpretations of historical architectural styles had been repeated on architects’ drawing boards throughout the 19th century, the German architect Heinrich Hübsch entitled his book with the question that symbolised the era “In welchem Style sollen wir bauen?” (In what style should we build?).60 In Glasgow, architects who longed for the artistic excitement of creating new architecture were influenced by the tradition of the French Beaux-Arts, the English Aesthetic movement, the refinement and revival of Scottish traditions, both academic and vernacular, and the Arts and Crafts movement from the 1890s.61 The image of Glasgow's city centre was changing; as the price of land was going up, so were the buildings, sometimes built on very small plots. New buildings were taller and often built of red stone instead of the earlier preferred pale-yellow or grey stone. The need to build faster and higher led to experimenting with new structural materials such as cast-iron, steel and

55 Cochrane, H., The Glasgow – the first 800 years, Glasgow, 1975, p.54
57 Ibidem, p. 160.
reinforced concrete. As the city’s wealth grew in great part from industrial engineering, there was no fear of applying new technologies in building. Glasgow architects John Baird (1798-1859) and James Thomson (1835-1905), and the engineer Robert McConnell, had been the first in Britain to experiment with cast-iron facades for commercial buildings. Baird’s earliest use of cast-iron was for the roof trusses in the Argyll Arcade, 28-32 Buchanan Street - 1827 (Plate 1.1). Baird’s and Thomson’s Italianate Iron Building at 36 Jamaica Street, built in 1856-7, was among first buildings whose street facade was almost completely made of glass panels placed between panelled cast-iron columns. Some tall buildings on small plots were built in Glasgow’s city centre around or at the same time as the Lion Chambers. James Salmon Jr designed one of them, the ‘Hat-rack’ (1902) at 144 St Vincent Street. As the architects were developing new design approaches for tall buildings, a brief overview of a few such buildings in Glasgow provides a background against which the unique design of the Lion Chambers stands out. The building design shows confidence in creating an asymmetrical facade, in using historical architectural details, in combining different shapes and sizes of windows and even placing them at slightly removed levels on the facade of the stair tower. The master behind the balanced proportions and historical detailing, who was not afraid to explore innovative solutions, was the architect John James Burnet (1857-1938), a son of the architect John Burnet Senior (1814-1901). His partner in the practice was John Archibald Campbell (1859-1909). The asymmetrical composition of the facade and the variations in size, shape and position of windows ought to have been noticed by the architects of the Lion Chambers. Burnet’s architectural skills, acquired at the École des Beaux Arts in Paris, and his easy adoption of new technologies and design solutions had delivered an architectural opus that...
quickly responded to the development of art and public taste from Victorian to Modern architecture. He successfully demonstrated how tall buildings could be designed on Atlantic Chambers (1899) at 43-47 Hope Street\(^66\), a commercial building with a ground floor and 6 storeys. Its large facade provided a surface on which the historical decorative repertoire was used to make a dynamic composition, topped with shaded loggias. The massive roof cornice is split by a vertical accent that rises from the ground floor level. There was no hesitation in introducing elements that assist in creating a balanced composition and in experimenting with their relationships. Burnet’s prediction of the future development of architecture is visible on the Kodak Building (1910-11, Kingsway, London) whose structure is expressed on the facades through the rhythm of columns accompanied by large glass surfaces and simple parapets between them\(^67\) (Plate 1.2)\(^68\).

The red sandstone main elevation, topped with a stepped gable, shows influences of Dutch town houses. Symmetrically placed sculptures at the upper part draw attention towards the dynamic forms above them. Semi-elliptical and semi-circular windows at top floors and narrow bays on the elevation towards the side lane had been used on other buildings in Glasgow’s city centre and were later reinterpreted on the Lion Chambers. The architect Robert Thomson (c. 1854-c. 1914) practiced in Glasgow from 1880.\(^69\) Nothing is known about his education or that of his business partner Andrew Wilson (c.1870-?)\(^70\). They also designed a former Glasgow Evening News Offices and the Printing Works at 67 Hope Street (1899-1907)\(^71\) in a similar way, but with two bays on upper floors as the building site was wider.

The building stands opposite the Athenaeum Theatre, but its design is closer to the above building by Robert Thomson than to J. J. Burnet’s. In 1877, at the age of eighteen, John

\(^66\) Extract from Statutory List, Glasgow City Council, HB number 33050, Category A. Available at www.glasgow.gov.uk, accessed on 23/03/2011


\(^68\) Extract from Statutory List, Glasgow City Council, HB number 32635, Category A. Available at www.glasgow.gov.uk, accessed on 23/03/2011


\(^71\) Extract from Statutory List, Glasgow City Council, HB number 33051, Category B. Available at www.glasgow.gov.uk, accessed on 23/03/2011
Archibald Campbell (1859-1909)\textsuperscript{72} (Plate 1.3) started his architectural education in the office of John Burnet Sr (1814-1901)\textsuperscript{73}, a self-taught architect who designed a range of buildings in different historical styles such as the reconstruction of the Union Bank at 30-40 St Vincent Place (1870-73)\textsuperscript{74}, Merchants’ House at 7 West George Street (1874-78)\textsuperscript{75}, Glasgow Stock Exchange at 159 Buchanan Street (1875-7)\textsuperscript{76} and Lanarkshire House (now The Corinthian), 191 Ingram Street (1876-9)\textsuperscript{77}. The architect John James Burnet, son of John Burnet Sr, returned from the atelier of Jean Louis Pascal (1837-1920) in Paris to his father’s office also in 1877, and in 1880 took Campbell to Pascal’s atelier. Campbell was admitted to the École des Beaux-Arts and returned to the Burnet practice in 1883, and became a partner in 1886 in John Burnet, Son & Campbell.\textsuperscript{78} The partnership was dissolved in 1897. Campbell later designed a tall red stone office building at 157-167 Hope Street with asymmetrical elevation to West George Street (1902)\textsuperscript{79}, south of the Lion Chambers. Campbell’s Northern Insurance Building at 84-94 St. Vincent Street (1908)\textsuperscript{80} stands on a wider plot and has a ground floor and six storeys. The composition of the large facade topped with protruding roof cornices, which are divided in two sections by a central tower, is a reinterpretation of J. J. Burnet’s Atlantic Chambers (1899) at 43-45 Hope Street, but the large windows without frames and architraves from the third to fifth floor and

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\textsuperscript{73} Dictionary of Scottish Architects, John Burnet (senior), http://www.scottisharchitects.org.uk, accessed on 01/04/2011.
\textsuperscript{74} Extract from Statutory List, Glasgow City Council, HB number 32841, Category A. Available at www.glasgow.gov.uk, accessed on 23/03/2011
\textsuperscript{75} Extract from Statutory List, Glasgow City Council, HB number 32689, Category A. Available at www.glasgow.gov.uk, accessed on 23/03/2011
\textsuperscript{76} Extract from Statutory List, Glasgow City Council, HB number 33089, Category A. Available at www.glasgow.gov.uk, accessed on 23/03/2011
\textsuperscript{77} Extract from Statutory List, Glasgow City Council, HB number 32735, Category A. Available at www.glasgow.gov.uk, accessed on 23/03/2011
\textsuperscript{79} Extract from Statutory List, Glasgow City Council, HB number 33053, Category A. Available at www.glasgow.gov.uk, accessed on 23/03/2011
\textsuperscript{80} Extract from Statutory List, Glasgow City Council, HB number 33153, Category A. Available at www.glasgow.gov.uk, accessed on 23/03/2011
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The use of large windows and slim pilasters between them. Traditional bay windows with stone parapets were transformed into glass lanterns projected into open space, including two individual semi-circular oriel windows above the entrances. The lightness of the facade led to a playful composition of windows, cornices and balconies, finishing with a hat-rack like top that was responsible for the building’s name. The main entrance has a marble finish on the floor and lower half of the walls, and leads towards an intricately decorated wrought-iron lift shaft.

1.2.1 Salmon Son & Gillespie Architects

A set of thirteen plans of the Lion Chambers, dated from April 1904 until January 1906, bear the signature Messrs. Salmon & Son & Gillespie Architects. As James Salmon Jr represented the third generation of architects in his family, the architectural opus, professional and social links of his grandfather James Sr and father William Forrest were an inherited background for learning and finding his own place as an architect. Both James Sr and William Forrest Salmon were leading figures and influenced the development of the architectural profession in the West of Scotland. A brief overview of the family’s professional, social and cultural legacy is presented. This is followed by an overview of James Salmon Jr’s education and experience before joining his father’s firm. John Gaff Gillespie’s education is briefly presented before providing an overview of his collaboration with James Salmon Jr.

69 Bothwell Street and of the Lion Chambers (1907). Shallow bay windows on facades facing narrow lanes in Glasgow’s city centre have since become almost a standard solution.

In contrast with the heavy stone facades of the above buildings, James Salmon Jr’s first tall building (Plate 1.4) looks light and transparent with its huge glass surfaces. This striking visual difference is due to the innovative structural system of steel frames that carry the building load. As the front facade did not need to carry the weight of the floors, it was constructed as a ‘curtain wall’. This structural invention enabled

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81 Messrs. Salmon & Son & Gillespie Architects, 53 Bothwell St, Glasgow, March 1905. Proposed Building Hope Street for Wm Geo Black Esq. The Mitchell Library Archive, Glasgow
James Salmon Sr (1805-1888) initially worked with John Brash (c.1775-1848), a Glasgow architect. Brash designed buildings at Blythswood Square (1823-29) whose general arrangement was determined by a plan made by Gillespie Graham (1776-1855) in 1820. The square emulated the scale and architecture of Edinburgh’s Georgian New Town. Between 1825 and 1830, Salmon Sr opened his own office. In 1843, he formed a partnership with the architect Robert Black which lasted until 1854 under the name Black & Salmon. In 1849, he designed St Matthew’s Church in Bath Street (destroyed by fire in 1952 and demolished) and a Renaissance warehouse at 81 Miller Street (1849-50) for the art collector Archibald McLellan (1795-1854), the founder of the McLellan Galleries. In 1854, Salmon Sr designed a housing scheme in Dennistoun, the area where he lived, that was partly built in the 1860s. He was also a property developer and an estate agent. In the 1850’s, he was active in promoting the Glasgow Architectural Exhibition in 1853 and assisted in founding the Glasgow Architectural Society in 1858 as proposer and first Vice-President. In 1868, he became first President of the newly founded Glasgow Institute of Architects whose Vice-President was Alexander Thomson (1817-1875). Salmon Sr was politically active and rose to the position of a Bailie of the City, contributing to the development of better housing for the working classes.

William Forrest Salmon (1843-1911) started architectural apprenticeship with the architect James Smith (1808-1863) around 1857. There he met William Scott Morton (1840-1903) and followed him to George Gilbert Scott’s (1811-1878) office in London. He returned to Glasgow around 1866 and became a partner in his father’s firm along with James Ritchie (1835-1910). The practice name was Salmon, Son & Ritchie until 1872, when Ritchie left, and the practice name was changed to James Salmon & Son. William’s links with Morton strengthened in 1872 when he married Jessie Alexander (1843-1887), a younger sister of Morton’s wife Elizabeth. Through this link the...
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practice maintained contacts with London as the Scott Mortons98 expanded their business in furniture, oriental carpets, upholstery and wallpaper first to the capital and then to New York in 1889. The circle of artistic interests in the family extended after William Forrest’s sister Helen Russell Salmon married the Yorkshire-born animal painter Tom Hunt. With his London friend Axel Haig (1835-1921), famous for his architectural etchings99, William Forrest went on his first visit to Italy.100 He was also a friend of William McTaggart (1835–1910)101, the leading Scottish landscape painter of his lifetime, and the sculptors Derwent Wood (1871-1926), Albert Hodge (1875-1917) and Johan Keller (1863-1944).102

With his father, William Forrest was also a founder member of the Glasgow Institute of Architects in 1868 and later its President. As his father, William Forrest was also a successful businessman.103 He was a Governor at the School of Art in 1893-1910; during this period he undertook a number of roles and sat on a variety of sub groups. He also acted as an Examiner and a Visiting member of staff in various capacities between 1893 and 1910.104 He was a close friend and supporter of Francis Henry Newbery (1855-1946), the Headmaster of the School of Art from 1885 until 1918, and his development of its Arts and Crafts credo and curriculum.105 As the practice reputation was high, the leading figures in late nineteenth century Scottish architecture worked there, including James Marjoribanks McLaren (1843–1890) and Sir George Washington Browne (1853–1939). As William Forrest returned from London to his father’s office in 1866, he could have contributed to the design of the Franco-Italian gothic former Deaf & Dumb Institute, Langside (1866–8).106

Changes in the architectural outputs of the practice appeared through the works of John Gaff Gillespie and James Salmon Jr. At the start of the 20th century the practice became ‘one

98 In 1870 William Scott Morton (1840-1903) and his brother John set up the Morton and Co furniture business in the Tynecastle area of Edinburgh. As a young man William attended decorative design classes in Glasgow and was apprenticed to the Glasgow architect James Smith. He had gained experience from several jobs in London, including work in the 1860s at Johnstone, Jeanes and Co furnishings, New Bond Street. As well as producing furniture, Morton and Co stocked oriental carpets and other upholstery. In the 1870s the firm began to make wallpaper, and became renowned for their invention of Tynecastle Tapestry, a canvas wall covering inspired by 15th-16th century Spanish and Italian embossed leather wall hangings. The 3-D nature of the canvas and the revolutionary way in which it was made meant that it was a more economic, lighter, yet durable, alternative to plasterwork. Tynecastle Tapestry was ideal for frieze decoration, ceilings and ships’ saloons as well as walls. From the late 19th century onwards Scott Morton and Co provided furnishings and fixtures for many prestigious houses including 25 Learmonth Terrace, Edinburgh; Norwood House, Aberdeen; and Holyrood Palace, Edinburgh. Royal Commission on the Ancient and Historical Monuments of Scotland, Canmore, Scott Morton, http://canmore.rahms.gov.uk, accessed on 25/03/2011.
99 At the end of the nineteenth and at the beginning of the twentieth century, Axel Hermann Haig was one of Britain’s most famous etchers. Haig, however, was actually born and raised on Gotland Island, Sweden, and initially studied naval architecture. Later, he settled in London and began working for several architects. Haig studied etching in his spare hours and within several years began producing the large architectural views that made him famous. His art in this medium quickly gained national recognition and Axel Haig became a regular exhibitor at the prestigious Royal Academy. He was also a full member of the Royal Society of Etchers and Engravers. Art of the Print. Axel Hermann Haig, www.artoftheprint.com, accessed on 25/03/2011.
104 The Glasgow School of Art, Annual Reports (GSAA/GOV/1), 1878-1910, The Glasgow School of Art Archives and Collections Centre. During the 19th century Headmasters (Directors) of Glasgow School of Art were Henry Macmanus, 1844-1848; Charles Heath Wilson, 1849-1864; Robert Greenlees, 1863-1881; Thomas C Simmonds, 1881-1885; Francis Henry Newbery, 1885-1918, Ibid.
of the most stylistically visionary in Glasgow, if not Britain, and one whose work was reported upon favourably in the English, French and German press as ‘the firm’s work proceeded to traverse between the dusk of the Victorian age through to the dawning of the Edwardian, migrating from the era of traditional load-bearing masonry construction, through the advent of the steel frame and the development of the cantilever, ultimately concluding with the monolithic structural system of reinforced concrete.’107 This transformation of the practice output was supported by William Forrest Salmon. Although not an innovative architect himself, Forrest Salmon had an insight into emerging changes in architecture through the engagement with the School of Art in which Francis Henry Newbery supported the students to explore and innovate. Forrest Salmon’s awareness of the times to come is explicit in a talk given in 1893:

“At the present time there exists a strong tendency to advance in architectural development. A spirit of dissatisfaction with the later productions is everywhere manifesting itself, and a true appreciation of what architecture is appears to be taking possession of a thoughtful section of the public. Those practising architecture have become aware that it will not suffice to plan a building, and then clothe its nakedness in the architectural details of a Greek temple or a Gothic cathedral, but that each building must be a living expression of its own uses. If it is to exist as an abiding work of art, it must tell its story not only to its own generation, but to the generation following.”108

James Salmon Jr (1873-1924) was initially educated privately and sent to Glasgow High School in September 1883, remaining there until 1888 when he joined the family firm for two years109. In 1887, his mother died suddenly110 and then his grandfather James Salmon Sr died on 5 June in 1888 ‘when walking home after giving one of his celebrated after-dinner speeches.’111 His father remarried in 1889 to Agnes Cooper Barry, who brought with her a much younger sister Charlotte, but Salmon Jr and his younger brother Hugh were not fond of Agnes, referring to her as ‘Steppy’. Hugh left the family home in 1894 to work for his maternal grandfather at Arrat Mill, Brechin, Aberdeenshire112, and then, in 1898, emigrated to New Zealand.113

In 1890, Salmon Jr’s architectural apprenticeship continued in the office of the architect and artist William Leiper (1839-1916), a close friend of his father.114 Leiper’s architectural production was a lively mix of styles such as Franco-Scottish on Colearn castle in Perthshire (1869-74), Dalmore in Helensburgh (1873), and Kinlochmoidart, Inverness-shire (1884); Anglo-Japanese interiors in Cairndhu, Helensburgh (1871); and arts-and-crafts and Scots baronial at Endrick Lodge, Stirling (c.1900). Leiper was also a talented painter who exhibited works

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107 Ibidem, p.31.
110 Ibidem.
111 Ibidem.
113 Ibidem, p. 41.
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in watercolour and oil as well as architecture from 1870 onward, and was elected associate of the Royal Scottish Academy in 1891 and full member in 1896. He is also mentioned as the interior designer of the steam yacht ‘Livadia’.115 Leiper’s flamboyant style is evident on the polychrome red stone, brick and tile Venetian Gothic Templeton Factory at 62 Templeton Street (1889)116 and the huge Sun Insurance Building at the corner of 117-121 West George Street and 38-42 Renfield Street in style of Francois Ier (1893-94).117 The latter received a Silver Medal at the Paris Exhibition of 1900.118 As Salmon Jr worked on the drawings for the Sun Insurance Building, the award must have been a boost to his professional aspirations. He might have visited the Paris Exhibition 1900 and seen reinforced concrete buildings exhibited by Hennebique and other engineers.

While in Leiper’s office, Salmon Jr worked under the direction of William James Anderson (1864-1900) on Glasgow Green (1888-1892) and probably saw Anderson’s project for the Orient Building (1892-95) in which reinforced concrete floors and ceilings and flat roof were used.119 Salmon Jr worked in a friendly studio atmosphere in Leiper’s office ‘whose staff were often invited home, particularly at the time of the strawberry crop, and taken on a cycling tour’.120 He left Leiper’s office in 1894,121 but Leiper’s imaginative and daring approach to architectural design is recognisable in his later projects.

In April 1894, when Salmon Jr was twenty one, he received from his father an appropriate birthday present for an aspiring young architect - a Grand Tour (from Pisa to Venice in Italy and Lucerne in Switzerland)122 during which he painted watercolours between April and July of that year. In 1895, he completed his prolonged studying at the Glasgow School of Art which he had started in 1889123 and began working in the family firm where John Gaff Gillespie, three years older than Salmon Jr, was in charge of most of the design work.124

At the time when James started studying at the Glasgow School of Art, Francis Henry Newbery held the post of Headmaster since 1885 and led the school successfully until 1918. The School became internationally acclaimed following the work of its graduates such as the architect and designer Charles Rennie Mackintosh; the designers Margaret Macdonald (1864-1933) and Frances Macdonald (1873-1921); the artist and designer Herbert McNair (1868-1955); the painter and illustrator Jessie M. King (1875-1949) and others working in the 1890s in Glasgow.125

As Charles Rennie Mackintosh started attending either early morning or late evening classes at the Glasgow School of Art from 1883 and enrolled as a student each year until 1894126,

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115 Cochrane, H., op. cit., p. 51.
120 Ibidem.
124 Ibidem.
he could have met James Salmon Jr, who had also studied there from 1889 until 1895, and John Gaff Gillespie who started his studies in 1884 and won the Glasgow Institute of Architects prize in 1889 jointly with Mackintosh.\textsuperscript{127} In 1892 and 1893, Mackintosh and Salmon Jr exhibited their sketches and watercolours at the Glasgow Institute of the Fine Arts.\textsuperscript{128} In 1897, James’ younger brother Hugh Alexander Salmon (1874-1960) went to New Zealand where he stayed and kept contact with James through letters for many years.\textsuperscript{129} James’ letters were accompanied with sketches, some of architecture, others as symbolic vignettes of his longing for Hugh’s letters, e.g. a cartoon sketch of both of them at the opposite ends of an elongated oval table (which could represent the Earth) writing to each other and waiting six weeks for a letter to arrive from Glasgow to New Zealand and six weeks for a reply (dated Monday, 10th September 1900). Hugh Alexander treasured his brother’s letters and kept a Journal in which he collected them.\textsuperscript{130} The development of a friendship between Salmon Jr and Mackintosh was also influenced by the departure of the artists James Herbert MacNair (1868-1955) and Frances Macdonald (1873-1921), his wife and the sister of Margaret Macdonald (1864-1933), to Liverpool in 1898. Until then, Mackintosh, MacNair and the Macdonald sisters, who all met at the School of Art and had similar ideas on art, closely collaborated and were known as The Four.\textsuperscript{131} Salmon Jr wrote to his brother in April 1899 that Mackintosh was engaged to be married to Margaret Macdonald and had come to Salmon’s new family home Rowantreehill in Kilmacolm to stay over Sunday. At that time Mackintosh was designing Windyhill (1899-1901), a house on a plot of land adjacent to Rowantreehill, and could have also come later to check the progress.\textsuperscript{132} It had been noted that Salmon Jr won a larger share of the market among those prepared to build stylistically adventurous houses than Mackintosh, including a series of houses at Kilmacolm whose interiors were a simplified version of Mackintosh style with inventive light fittings designed by Salmon Jr himself.\textsuperscript{133} One of Salmon Jr’s designs in Kilmacolm is the extension of a late-Victorian villa on Gryffe Road whose plans were submitted early in 1906, incorporating certain forms and details which had appeared the previous year in the concrete tower of the Lion Chambers.\textsuperscript{134} Archibald Ferguson, a lawyer who had an office in the Lion Chambers, commissioned Salmon Jr to design his house, Nether Knockbuckle, in Kilmacolm in 1907, on which architectural expression was simplified more than ever before.\textsuperscript{135} The friendship between Salmon and Mackintosh led to mutual influences in architecture. Mackintosh’s influence in the design of Salmon’s

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\textsuperscript{130} Op. cit., p.29.
\textsuperscript{133} Walker, D., 1996, p.146-7.
\textsuperscript{135} Ibidem, p. 117.
and Gillespie’s hall of St Andrew’s-in-the-East Church in Alexandra Parade, in Glasgow (1899) has been suggested. These influences emerged from some overlaps in their design philosophies. Their public lectures provide insights into what they considered important in design and enable a better understanding of their architecture. The freedom of architectural design was the reason for John Ruskin’s (1819-1900) passionate love for Gothic architecture. His books, such as The Stones of Venice (1851-53), were read again. Mackintosh quoted Ruskin in his first lecture on contemporary architecture (around 1892):

“…And it is one of the chief virtues of the Gothic builders that they never suffered ideas of outside symmetries and consistency to interfere with the real use and value of what they did. If they wanted a window they opened one; a room, they added one; a buttress they built one; utterly regardless of any established conventionalities of external appearance knowing (as indeed it always happened) that such daring interruptions of the formal plan would rather give additional interest to its symmetry than injure it.”

Asymmetrical design of building form and facades, and purpose-directed placement of windows are also present in Scottish vernacular architecture and its academic interpretations. In his second lecture Mackintosh wrote that ‘all great and living architecture has been the direct expression of the needs and beliefs of man at the time of its creation’ and that ‘to get architecture the architect must be one of a body of artists possessing an intimate knowledge of the crafts.’ However, Mackintosh had not followed the first idea as far as Salmon had through the experimentation with steel and reinforced concrete structures. In 1908, Salmon Jr gave a lecture to the Glasgow Institute of Architects on ‘The Decoration of Steel and Reinforced Concrete Structures’, indicating the approach taken in designing the Lion Chambers:

“The Scottish style, I mean especially that of the old rough-cast castle, is eminently adapted to a development suited to reinforced concrete construction – the plain rough-cast surfaces, extending to the window sashes, and simple corbelling, the small cornices, the straight lines, the rarity of arches, and other details difficult to construct: Above all, the freedom to do anything you like provided the shapes suit your material wants, and group well with the natural surroundings. Ruskin is fundamentally wrong when he says that architecture must be carefully distinguished from building. Building is architecture. If this new material, reinforced concrete, could induce us to drop all the ridiculous accretion of absurdities which we plaster on to stone, it will indeed have lifted a weight from a world overladen with “ornaments” and “decorators”’. Salmon Jr also gave lectures to architecture students at the School of Art and the Liberal and Art Clubs. Throughout his career, Salmon Jr

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was an active participant of the contemporary art, urban and architectural scene, and in political circles; he was a member of the Scottish Society of Art Workers, the Glasgow Art Club, the Chelsea Arts Club, the Garden City Association, the Liberal Club, the Wrights and the Hammermen, and the first editor of the journal of the Royal Incorporation of Architects in Scotland from its incorporation in 1922 until his death in 1924. Salmon Jr’s architectural designs stood alone among all of the Glasgow Style designers in its affinity with Continental Art Nouveau and the emerging Modern Movement. Historians of architecture agree that of Mackintosh’s contemporaries the nearest to him in spirit was James Salmon Jr. The careers of the two friends ended in a similar way as ‘sadly, after the Edwardian decade Glaswegians seemed no longer to be impressed by what Mackintosh – or, for that matter, his friend James Salmon Jr – had to offer’. Salmon Jr’s letters to his brother also provide evidence of friendly relationships with artists Tom Hunt (who was married to his father’s sister), painter G. G. Anderson, painter and illustrator Stewart Orr (1872-1944), Roy Orr, Norman McLean, and the writer Neil Munro (1863–1930). Munro edited the Glasgow newspaper The Evening News, for which James contributed articles and cartoons. O’Donnell (2008) wrote:

“James’s letters to his brother reveal the whole man. The words, their phrasing, their hand-scription styling, the layout, the subject matter, the aesthetic and the sheer variety, humour, and character of the sketches, bring his spirit to life. His humanity, wit and personality beam off the pages and it is impossible to isolate the man from his art.”

For his lively character and a small stature, James was affectionately known as the ‘Wee Troot’ (a small trout). For his unorthodox political views, he was described as ‘a social and municipal Bolshe-vik… his views on the Parish Council, School Board, and Infirmary Managers cannot be published!’ Salmon Jr’s dynamism and daring views are embedded in the design of the “strange ‘Hatrack’ building and astonishing Lion Chambers in Glasgow (which) are among the most interesting buildings of the Edwardian period.”

John Gaff Gillespie (1870-1926) did not have a privileged start in life like Salmon Jr; he was the eldest of at least nine children of Alexander Gillespie, a Gorbals baker who originated from Duntocher, and his wife Margaret Gaff from Polmont. Gillespie had been an apprentice at the practice of James Milne Monro (1840-1921) from 1886 to 1891 while attending classes at the School of Art. As he won the Glasgow Institute of Architects prize in 1889 jointly with

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143 Gomme, A. and Walker, D., op. cit, p. 221.
149 Ibidem.
Mackintosh, William Forrest Salmon noticed him and employed in his firm in 1891. He was entrusted with the design of the Scottish Temperance League building at 108 Hope Street (1893-4)\(^{150}\) (Plate 1.5) which was designed in free Flemish Renaissance style, Pl. 5. His next project was the West of Scotland Convalescent Seaside Homes at Dunoon in 1895. From that year, Gillespie became a partner in the firm.\(^{151}\)

Professional collaboration of James Salmon Jr and John Gaff Gillespie

This brief overview of the professional collaboration of Salmon Jr and Gillespie includes only major projects.\(^{152}\) In 1895, when Gillespie became a partner in W. F. Salmon’s practice, Salmon Jr joined his father’s firm. He became a partner in 1898, but neither his nor Gillespie’s name was acknowledged in the practice title until November 1903 when the firm became Salmon, Son & Gillespie.\(^{153}\)

In letters to his brother, Salmon Jr wrote how the practice operated – each partner retained responsibility for certain work or clients.\(^{154}\) Change of the practice name to Salmon, Son & Gillespie in 1903 was explained as a progressive step. Salmon Jr and Gillespie undertook many trips together for study and leisure. They researched and travelled extensively to study examples of relevant contemporary buildings to inform the projects that they were undertaking.\(^{155}\) They were friends with Ernest Archibald Taylor (1874-1951), a designer of furniture and Lecturer (1903-05) at the School of Art, and later a designer of stained glass windows, and a painter.\(^{156}\) They also employed craftsmen such as John Crawford who had a woodcarving business with his brother, and produced woodwork for building and ship interiors, including a woodwork carved to designs by Salmon Jr and Gillespie that was displayed at exhibitions in Glasgow (1901), Turin and Budapest in (1902).\(^{157}\)

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\(^{152}\) A comprehensive list of all projects and competitions is provided in O’Donnell, R., 2003.

\(^{153}\) Ibidem.


\(^{155}\) Ibidem.


\(^{157}\) Ibidem, p. 16.
The next project acquired by the practice, the Mercantile Chambers (1897) at 39-69 Bothwell Street (Plate 1.6), was entrusted to Salmon Jr. This red stone building was one of the largest steel-framed office blocks in Glasgow.\(^{158}\) There is no indication of the nature of the internal structure on the elevation to Bothwell Street. Decorations on the main facades include some elements of international Art Nouveau and sculptures by Derwent Wood.\(^{159}\) The real novelty is the elevation to Bothwell Lane which had eight bays of shallow, canted metal-framed windows rising full-height from the first floor (Plate 1.7). This design feature was reinterpreted on the north facade of the Lion Chambers. In 1897-99, Salmon Jr and Gillespie contributed to the design of the interior of 22 Park Circus in Glasgow (1872-74)\(^{160}\). The house is within the Park Circus terrace whose architect was Charles Wilson (1810-1863).\(^{161}\) The sumptuously stuccoed and sculptured interiors were designed by James Boucher\(^{162}\) (1826-1906).\(^{163}\) New chimneypieces in the Art Nouveau style were installed with woodcarving executed by Derwent Wood. Several principal rooms, including a billiard room, were also designed in Art Nouveau style and are considered among the finest pieces of British Art Nouveau.\(^{164}\)

In 1899, the practice was busy with the projects that introduced Art Nouveau details on elevations of the hall of St. Andrews-in-the-East in Alexandra Parade\(^{165}\), the British Linen Bank at 816-818 Govan Road\(^{166}\) and the Savings Bank...
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The fully blown Art Nouveau was developed in the design of the 'Hat-rack' building in Glasgow’s city centre, Pl. 4. When it was planned, Salmon Jr wrote to his brother in 1899 that the practice ‘will probably be starting the highest building in Europe’ and sent a small sketch on the edge of the letter of the proposed building facade which resembles an early perspective sketch of the ‘Hat-rack’.\(^{169}\) He also commented on difficulties with the building authority to develop tall buildings and provided, as an example, information that the architect John James Burnet had two storeys cut off a proposed ten-storey building.\(^{170}\) However, the warrant for the ‘Hat-rack’ was granted and the work started in July 1899.\(^{171}\)

Building high was a new challenge for architects that led to an underlining competition that could be sensed from Salmon Jr’s comment that the architect James Thomson (1835-1905) was designing a tall building almost opposite the ‘Hat-rack’ and that they were ‘going to race him’.\(^{172}\) However, Thomson’s building at 199-123 St Vincent Street (1899) has only a ground floor, 5 storeys and an attic.\(^{173}\) Another competitor in the race for taller buildings was John Archibald Campbell whose designs for red stone buildings with a ground floor and seven storeys, influenced by American architecture, were completed at 157-167 Hope Street\(^ {174}\) and 50 Argyle Street in 1905.\(^ {175}\)

With the basement, ground floor, seven storeys and attic, the ‘Hat-rack’ was the tallest building in Glasgow at that time.\(^ {176}\) The building attracted international attention - five pages were devoted to Salmon Jr’s work in \textit{L’Art Decoratif} in 1899.\(^ {177}\)

\(^{170}\) Ibidem, p. 34.
\(^{171}\) Ibidem, p. 34.
\(^{172}\) Ibidem, p. 35.
\(^{177}\) Ibidem.
Gillespie designed houses at 12-14 University Gardens around 1900, and in 1901 the practice won a competition for the former Congregational Church at 155-57 Rutherglan Road (demolished). They were not successful with competition design for the Glasgow Technical College in 1901 with two versions of elevations, one in Renaissance style by Gillespie and the other in Art Nouveau style by Salmon Jr. In 1902, the practice submitted two competition designs, for the Rutherglen Public Library and the Newton Park School in Ayr, but neither was selected. In 1902-04, the partners designed a nurses’ home at Woodilee Hospital in Lenzie, near Glasgow (demolished). In 1903, Salmon Jr and Gillespie remodelled the facade of an existing building at 79 West Regent Street with Glasgow’s Art Nouveau details. This building stands at the corner with Hope Street, diagonally opposite to the offices of the lawyer William George Black, the client of the Lion Chambers. Before presenting this project in more detail, a brief overview is provided of the most important projects that followed before the practice was dissolved.

In 1904, Gillespie designed Lanfine Cottage Hospital, Broomhill, Kirkintilloch, now derelict. A series of five private houses in Kilmacolm, designed by Salmon Jr, also kept the practice busy. The Salmons lived in Rowantreehill house, a family home since 1898, designed by Salmon Jr but owned by his father William Forrest. Rowantreehill house is a mixture of Scottish and English styles with some Art Nouveau details. The next house was Miyanoshita (1904) whose design signalled Salmon Jr’s exploration of new approaches to the design of rural houses starting with simple forms and minimal Art Nouveau decorative accents. The extension of Northernhay, a late Victorian villa on Gryffe Road, in 1905, included a few details from the concrete tower on the Lion Chambers. The Tudor-inspired design of Hazelhope (formerly Dilkush) in 1906 returned to earlier inspirations for housing design, while the Den o’Gryffe house (1905) shows influence of Charles Voysey (1857-1941), English Arts and Crafts architect and designer. However, the extension of Den o’Gryffe house in 1907 demonstrated that Salmon Jr’s explorative design approach was directed towards simplification of form and detail. The simplicity of design of the Den o’Gryffe house (1905-07), followed the work on the Lion Chambers on which Salmon Jr proposed a version of an office building stripped of decoration, but imbued with Scottish architectural tradition in its forms and the truthful expression of building materials. Archibald Ferguson, one of the lawyers who had an office in the Lion Chambers, commissioned Salmon Jr to design the Nether Knockbuckle house in Kilmacolm whose architectural expression had been simplified more than in any previous house design, demonstrating another step in the direction of the Modern Movement. The house in Edzell (Angus), designed by Salmon Jr.
in 1906, offered an Arts and Crafts version of the Scottish style\textsuperscript{187} in a compact form built of red stone rubble\textsuperscript{188}. The practice proposed a reinforced concrete structure in the competition projects for the Mitchell Library in Glasgow (1905) in Renaissance style and the Glamorgan County Offices (1909) in Free Baroque style which were not won.\textsuperscript{189} In 1906-08, the practice designed a school at Cartsburn, Greenock, destroyed in the Second World War.\textsuperscript{190} In 1907, Salmon Jr participated unsuccessfully in the design competition for the Glasgow Liberal Club with a huge cube whose facades were divided by colossal columns above the first floor and bay windows between them.\textsuperscript{191} The proposed building form and articulation of elevations, although more restrained, were present in J. J. Burnet’s design for the McGeoch’s Ironmongery Store in West Campbell Street (1905)\textsuperscript{192}, now demolished.\textsuperscript{193} The competition designs for the London County Hall and the Perth City Hall in 1907, the Hamilton New Academy and the extension of Rutherglen Town Hall in 1909 were all liberal interpretations of historic styles, but had not been selected. Gillespie was successful with his competition design for the Stirling Municipal Buildings in 1907\textsuperscript{194}, inspired by Scotland’s early 16th century architecture, and for the Pollock Golf Clubhouse in 1911.\textsuperscript{195} The practice used reinforced concrete structure and brick block for the west extension of the Cranstonhill Bakery, 38-42 Cranston Street, in 1912 (demolished in 1969).\textsuperscript{196} The use of brick block instead of concrete panels raises a question of whether at that time the partners had understood that concrete without thermal insulation was not suitable for external walls.

As there was little interest for innovative design of public buildings, the partners returned to historical styles in competition designs. However, just as Salmon Jr, Gillespie was also interested in new design approaches and building materials. His design submitted for the British Architect concrete design competition in 1909 signalled a direction towards Art Deco.\textsuperscript{197} When William Forrest Salmon died on 11th October 1911, the partnership was destabilised by his will in which his share of the business was not mentioned, leaving his second wife Agnes as a partner whose share of the business Salmon Jr could not afford to buy out and which Gillespie did not want, leading to the end of the partnership 18 months later, in 1913.\textsuperscript{198} As Salmon Jr lost the family home in Kilmacolm, he moved into a flat in Blythswood Square where he set up his practice.\textsuperscript{199} The split between the partners was amicable.\textsuperscript{200}

\begin{thebibliography}{99}
\bibitem{187} Walker, D., 1975, p. 245.
\bibitem{189} O’Donnell, R., 2003, p. 46.
\bibitem{190} Walker, D., 1975, p. 245.
\bibitem{191} Ibidem, p. 247.
\bibitem{192} Perspective drawing in O’Donnell, 2003, p. 15.
\bibitem{195} Walker, D., 1975, p. 247.
\bibitem{197} Walker, D., 1975, p. 247.
\bibitem{198} O’Donnell, R., 2003, p. 49.
\bibitem{199} Ibidem, 54.
\bibitem{200} Ibidem, 129.
\end{thebibliography}
1.2.2 The Lion Chambers client

William George Black (1857–1932) was a respected and socially active Glaswegian. He was educated at the University of Glasgow and Gottingen in 1879. In 1884, he became a partner in his father’s legal firm Black, Honeyman and Monteath. His interests included art and publishing on legal, archaeological and anthropological subjects. He was a member of the New, Art, and College Clubs, Glasgow; the University Club, Edinburgh; and the Royal Societies Club, London. His wife Anna Robertson was a daughter of Robert Blackie, of Blackie & Sons publishers, and a niece of John Blackie (1805-1873) who became Lord Provost of Glasgow in 1863 and initiated the City Improvement Scheme that transformed housing for the poor and the city’s infrastructure.

Black was Deacon of the Trades House of Glasgow in 1916-17. For his work during the First World War, in Voluntary Aid Detachment committees, in helping disabled officers and in the post-war training of officers, he was made CBE. His public activities included being a governor of Baillie’s Institution, a member of council of the Regality Club and of the Master Court of the Weavers Incorporation, vice-chairman of St Mungo’s College and chairman of the Ophthalmic Institution of Glasgow. In 1930, he presented the Mercat Cross which stands in the Merchant City in Glasgow.

Salmon Jr continued working on smaller projects for the Scottish National Council during the First World War, and carrying out mainly domestic and hospital work until his death in 1924. He also continued to pursue his architectural interests as the first editor of the RIAS journal established in 1922, and his interests in social reform and working class conditions.

Gillespie employed the architect Jack Antonio Coia (1898-1981) in 1915, who also worked for other architects and then went to London, and made William Alexander Kidd (1879-1928) a partner in 1918. When Gillespie died in 1926, Kidd invited Coia to return to the practice; their partnership lasted until Kidd’s death in 1928. Coia inherited the practice and continued it as Gillespie, Kidd and Coia. The Modern Movement design approach was taken on and developed further by Isi Metzstein who joined the practice in 1945 and Andrew MacMillan who joined in 1954. The work of the practice between 1958 and 1987 was a subject of the exhibition in The Lighthouse, Glasgow, in 2008, and a book.

A century before that exhibition, the Lion Chambers was the first sign of the Modern Movement in Scotland that fully developed through the 20th century. In 1904-5, Salmon Jr and Gillespie worked on an innovative design for a new office building for William George Black, the client who was as brave as they were to experiment.

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203 Ibidem.
As a member of the Glasgow Art Club, whose premises, designed by the architect John Keppie (1862-1945), also the club member, were at 185 Bath Street since 1893, Black could have met there not only the artists but also the architects who worked in Glasgow.

Black owned the building at 168 Hope Street at the corner with West Regent Street. It stands diagonally opposite the house at the corner of 79 West Regent Street and 183-191 Hope Street, built in the mid 19th century and altered to offices, tearooms and a restaurant by Salmon, Son and Gillespie in 1903. These alteration works would have been noticed by Black as well as Salmon Jr's impressive tall building the ‘Hat-rack’ (1902) that can be seen while walking from Central Station up Hope Street, as it stands close to the corner with St Vincent’s Street. Black could have met Salmon Jr in Glasgow’s art circles, but was also able to see the originality and virtuosity of the ‘Hat-rack’ close to his offices. It is not then surprising that Black commissioned Salmon, Son and Gillespie to design the Lion Chambers in 1904.
4.1 The case studies

The analysis undertaken so far and the discussion on tentative diagnoses need to be applied on site and require a validation of obtained data. Therefore, two case studies were selected, two architectural examples that represent two significant moments in the architectural culture of the places in which they emerged. Their importance is fundamentally linked to what they represent in the architectural debate on techniques and technologies regarding the construction sector at the start of the 20th century. The buildings are the Lion Chambers in Glasgow (Plate 4.1), designed by the Scottish architects J. Salmon Jr and J. Gillespie and built between 1904 and 1907, and the Duni Theatre in Matera (Plate 4.2), designed by the Materan architect E. Stella and built between 1946 and 1949.

These two buildings, although of different use (the first one is an office building for local lawyers, the second one is a movie theatre), time of construction, form and size, finishes and materials, technological and structural systems, are linked by being both among the first realisations in reinforced concrete in the places in which they were built. In fact, although built almost forty years apart, they represent a synthesis of what the debate in architectural field was in those years and in specific social, cultural and economic context in which the two buildings were concei-
4.2 The Lion Chambers - Glasgow (UK)

4.2.1 Building location – Hope Street and its environs and the adjacent building

The Lion Chambers was built at 172 Hope Street. The street leads uphill from Argyle Street at its south end to Cowcaddens Road at the north within the rectangular city centre grid. Transitions from Victorian architectural historicism to Edwardian ‘Free Style’, and then Art Nouveau and Modernism are vividly present in this street. If the architects’ names were on the buildings that they designed, the walk through the Hope Street would show a large part of ‘who was who’ list of the architects of that era.

One of the reasons for the concentration of big architectural names and their works in this street in the last decades of the 20th century was because this city area attracted investment for buildings around the Central Station which was built at the south end of Hope Street in 1879. The station was fronted with a huge Victorian building, planned initially as offices but opened as a hotel in 1884. It was designed in Northern European Renaissance style by the architect Sir Robert Rowand Anderson (1834-1921) and extended by James Miller (1860-1947) in 1900-8.² The four-storey building of polished ashlar carries a double attic composed of a series of decorated gables. The Central Station and the hotel created a monumental entrance for people and goods to Glasgow. Building plots in the streets in the vicinity of this busy area attracted investment in new buildings and challenged other architects to come up with impressive designs to demonstrate the prosperity of Glasgow at that time to visitors and businessmen.

The Lion Chambers rises on a small plot (46 ft 1 in by 33 ft 1 in)³ at the corner of Hope Street and Bath Lane, next to the building which was also owned by William George Black, as noted in the original site sketch drawing.⁴ A set

³ 14.05 m by 10.08 m. Measures provided in Anonymous. A reinforced concrete office building, The Builders Journal and Architectural Engineer: Concrete and Steel Supplement (Monthly), 30 January 1907.
of thirteen plans of the Lion Chambers were submitted to the city authorities on 1st June 1905, as indicated on one of them, but the dates on individual drawings show that they were made from April 1904 until April 1905. The plans of the existing building, south of the Lion Chambers, were also included (basement, ground floor, first floor and second floor). The facade view shows that there was a small, one-storey building with a pitched roof on the Lion Chambers plot.

The existing building to the south had a circular staircase in the northeast corner. The plans of the basement, ground floor and first floor of the Lion Chambers show that a connection with the existing building was planned by removing the circular staircase. Instead, a room was created at the basement of the existing building and the wall to the Lion Chambers basement removed. This remodelled basement space in the existing building was then covered with a pitched glass roof to provide natural light to both basements.

Next to the adapted basement room, simple new stairs and reinforced concrete columns were built to carry new corridors and a new set of toilets on the ground and first floor within the existing building. The new corridors at these floors are connected with the Lion Chambers. It was difficult to build a tall structure (90 ft from the pavement level and 100 ft from the basement level) in the limited space in Glasgow’s busy city centre. However, the contractors were as inventive as their construction system in solving this problem, as explained in more detail below.

4.2.2 Original building use, layout and services

The area available for a useful occupation of the nine floors of shops and offices is 11,070 sq feet. The basement and ground floor were planned for a firm of printers and stationers, the upper floors for lawyers’ offices, and the top floor for ‘artist painters’. William George Black’s links with artists and his philanthropic inclinations had probably influenced the decision to provide space for artists in his new building. As Anne Robertson Black, William’s wife,
was a daughter of the publisher Robert Blackie of Blackie and Sons Ltd founded in 1809\textsuperscript{9}, this publishing link might have led to planning the basement and ground floor spaces for a related business. The plan of the elevation to Hope Street shows the shop name ‘Douglas’.\textsuperscript{10} G. A. H. Douglas & Co are still listed at the address 172 Hope Street in Glasgow Online directory\textsuperscript{11} and the business name is still above the shop window, but the shop was vacated in late 2009 by its original occupants since 1907.\textsuperscript{12}

The open-plan basement and ground floor are connected to the adjacent building (Plate 4.3).\textsuperscript{13} The plan of the first floor, published in 1907,\textsuperscript{14} shows six offices in two groups, accessed from a divided entrance corridor that is connected to the stair landing (Plate 4.4). In each group, one of the offices was named as public and the other two as private rooms. There are two safe rooms, each accessed from one of the corridors. Separate rooms in an office building were an established layout concept, especially suited for lawyers’ offices where privacy of communication with clients is required. As the structure made of reinforced concrete columns and slabs provided an opportunity for open-plan spaces, they were created in the basement for printing works and at the ground floor for a shop.\textsuperscript{15}

Three studios were planned on the 7\textsuperscript{th} floor, each with two stoves and running water, according to the plans dated April 1905.\textsuperscript{16} Access to the top floor was made easier with the lift in the centre of the square staircase.

Some of the occupied rooms were heated with Carron stoves, installed by Carron Co.\textsuperscript{17} Others had fireplaces with cast iron mantelpieces.\textsuperscript{18} The position of each fireplace or stove was indicated in the plan with floor tiles and a surrounding border next to chimneys. Carron stoves are still

\textsuperscript{9} Records of Blackie & Son Ltd, publishers, Bishopriggs, Glasgow, Scotland. Archives hub at http://archiveshub.ac.uk, accessed on 24/03/2011.
\textsuperscript{10} Messrs. Salmon & Son & Gillespie Architects, 53 Bothwell St, Glasgow, Proposed Building Hope Street for Wm Geo Black Esq. Elevations, April 1905. The Mitchell Library Archive, Glasgow.
\textsuperscript{11} http://www.glasgowonline.co.uk, accessed on 29/03/2011.
\textsuperscript{13} Messrs. Salmon & Son & Gillespie Architects, 53 Bothwell St, Glasgow, April 19\textsuperscript{th} 1905. Proposed Building Hope Street for Wm Geo Black Esq. Ground floor plan. The Mitchell Library Archive, Glasgow.
\textsuperscript{14} Anonymous. A reinforced concrete office building, The Builders Journal and Architectural Engineer: Concrete and Steel Supplement (Monthly), 30 January 1907
\textsuperscript{15} Messrs. Salmon & Son & Gillespie Architects, 53 Bothwell St, Glasgow, April 19\textsuperscript{th} 1905. Proposed Building Hope Street for Wm Geo Black Esq. Ground floor plan. The Mitchell Library Archive, Glasgow.
\textsuperscript{16} Ibid, 7\textsuperscript{th} floor.
\textsuperscript{17} Anonymous. A reinforced concrete office building, The Builders Journal and Architectural Engineer: Concrete and Steel Supplement (Monthly), 30 January 1907
\textsuperscript{18} Messrs. Salmon & Son & Gillespie Architects, 53 Bothwell St, Glasgow, April 19\textsuperscript{th} 1905. Proposed Building Hope Street for Wm Geo Black Esq. Detail of SW office on 2\textsuperscript{nd} floor. The Mitchell Library Archive, Glasgow.
being made. The electric elevator installed in the Lion Chambers was among the earliest applications after its invention in 1902 by the Otis Elevator Co as the first system was installed in New York in 1904. Brothers Alexander and Peter Steven, who installed the elevator, set up in business as hydraulic engineers in 1850 and specialised in lifts. The electric lift they introduced in 1897 was one of the first made in Scotland.

4.2.3 Exterior design

Regarding the architectural design, the anonymous author of an article about the Lion Chambers, published in 1907, wrote the following:

“Messrs. Salmon and Son and Gillespie explain that the material and the purpose of building suggested the treatment. No effort was made to imitate a stone or brick building, but as ample daylight in office is of high importance in a city, large and projected windows were made the predominant features. The corner oriel window has been carried above the roof and finished with a dome, which has been made an internal feature of one of the studios on the top floor. Two modelled corbels, representing legal dignitaries, help to support the main oriel window. The name of the building, ‘Lion Chambers’, is given on the modelled panel, surmounted by the coat of arms and motto of the proprietor, which is intended to be painted in heraldic colours.”

Although the importance of the building material and purpose, and the need for natural light in offices were emphasised, the creative thinking that led to the final design was not explicit in the above comment, but was made clearer in Salmon Jr’s lecture in 1908. The design can also be better understood within the context of the ideas shared by the architects in Glasgow and the construction capabilities of that time. As the introduction of steel frames enabled the use of large glass surfaces on Glasgow’s building facades, Salmon Jr skilfully demonstrated on the ‘Hat-rack’ a novel approach to the design of facades. Reinforced concrete represented a new challenge for Salmon, Son and Gillespie. The design of the structure was in the safe hands of Hennebique’s engineers. However, regarding the building envelope, they provided only advice on the required thickness of the facade walls and external surface rendering. As the external walls of the Lion Chambers do not have thermal insulation, it is obvious that there was no awareness that reinforced concrete is an excellent thermal sink that absorbs summer heat and then releases it into rooms, and absorbs winter cold causing condensation of vapour on internal surfaces. Thus, the external walls, roof and foundation slab of the Lion Chambers behave as a ‘cold bridge’ in today’s terms. Unaware of this problem, Salmon, Son and Gillespie focused on designing elevations that provided required natural light to offices and adequately expressed the building material.

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21 Mitchell Library, GC 338.76218770941443 STE
Chapter 4

The west elevation to Hope Street (Plate 4.5) is an example of Glasgow Free Style in the way it transforms and combines elements of historical architectural forms such as the oriel corner windows topped with a domed tower and the triangular gable above the cantilevered windows. Asymmetrical facade composition and different shapes and sizes of windows were also used by some architects of the Glasgow Free Style. Simple, rounded window frames and the smooth wall finish, in complete contrast to the ‘Hat-rack’ building, show a radical departure from Art Nouveau in direction of Modernist architecture. This departure carried along memories of Scottish castellated architecture in the building’s slender form and almost white rendered elevations. However, the intention to experiment is visible in details such as the parabolic windows on the corner tower, a ‘nod’ to Antoni Gaudi’s use of parabolic arches. Two busts of lawyers above the third floor were the work of Johan Keller23, a Dutch sculptor who became a Professor at the Glasgow School of Art in 1898. Salmon Jr and Keller became good friends and went together on an extended tour of Europe in 1904.24

The elevation to Bath Lane is an even bolder move towards a direct expression of building structure, materials and functions without any additional decorative elements. Glass on the soaring bays allows access of natural light to offices and reflects light that hits the panes. The top end has a tighter rhythm of windows. A potential influence of the canted bays with steel casement on the rear elevations of the Lion Chambers and Mercantile Chambers on the design of the tall library oriel on the west facade of Glasgow School of Art has been suggested as Mackintosh revised the design of the still-unbuilt western third of the building in March 1907.25

The windows on the plain surface of the south elevation of the Lion Chambers are placed according to the internal need for light (Plate 4.6). The composition of the top part of the whole building is completed with a triangular gable on the south facade above the cornice linked to the west facade above the sixth flo-

23 Ibidem.
or. As the east elevation faces rear facades of other buildings in the block, it is finished as a full wall with a set of plain windows of utility spaces. The freedom of independent design of each elevation has been fully exploited to satisfy and express the functional needs of internal spaces. As the external concrete surfaces were originally rendered with pale yellow cement finish, the whole building was in contrast with its immediate environment, but also within Glasgow’s cityscape, apart from the equally bold south elevation of Mackintosh’s School of Art. True to their designer’s temperament, the Lion Chambers and the ‘Hat-rack’ were not shy to stand out and be noticed as the two ‘buildings that stood apart from the rest’.26

4.2.4 Interior design

In 1890, Glasgow’s City Chambers, designed by William Young27, were completed and amazed with its opulent and high quality interior finishes. In the list of contractors on the Lion Chambers28 there are some who had worked on the City Chambers, e.g. Galbreith & Winton, the contractors for tile and marble work, and George Adam, the contractor for wrought iron work who was a contractor for wrought-iron lamps in Glasgow’s City Chambers.29 This indicates that the quality of finishes, at least in publicly accessible spaces such as the entrance and staircase and in some offices, ought to have been very high.

A detailed plan of the office in the south-west corner on the 2nd floor, dated April 1905, shows how the interior design of this office was planned.30 A view of the north wall contains a fireplace and two doors in brown colour, skirtings, a picture rail at the level of the door frame, and a section through timber panelling below the

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bay window, indicating a distance between the external wall and timber panel. There is a note ‘C(ast) I(ron) mantel pieces throughout’ next to the fireplace.

The plan and view of the ‘south oriel’ windows indicates that the columns between them were panelled (Plate 4.7). The view of the east wall contains a door with framed glass on its upper part. There is a section through a timber cover for electric wires and a section through floor skirting with a note ‘cork carpet’. Cork is an excellent thermal insulator and sound absorber that would reduce noise transfer through concrete slabs.

A photograph of the office in the southeast corner at the fourth floor in the Lion Chambers demonstrates that the planned interior design was followed (Plate 4.8). The dark colour of the wall below the picture rail could be attributed to panelling or paint. The cast iron fireplace is reflected on a shiny dark surface of floor tiles placed in a frame. Compared to the contemporary fireplaces, the mantel piece is quite simple, decorated only with two circular motives in the corners below the top shelf. The carpet, table, chairs and a leather armchair could have been brought from another office. Window blinds, instead of curtains, and lighting with bulbs under white glass hats, instead of chandeliers, introduce a touch of simplicity seen in American contemporary offices.

The office looks sufficiently comfortable and welcoming, without intending to impress with luxurious detail. A partition wall was inserted later between the south and north walls of the room. The windows have been replaced; the fireplace is gone as are the tiles in front of it (Plate 4.9).

Some original details of interior finishes are still in place in the entrance hall such as a door on
the right side (Plate 4.10) and stair rail and wall tiles in shades of green at the ground level hall. The later panelling in the entrance hall covers the original tiles (Plate 4.11).

The bare simplicity of the interior design is evident in the detail of a corridor in the north part of the second floor (Plate 4.12). An exposed beam rests on the column between the office doors. Natural light floods the rooms through large windows and penetrates the corridor through glass on the doors and above them. Large windows and low parapets span spaces between columns on the north facade (Plate 4.13).

Strait lines of light shelving complement the geometrical simplicity of the rooms. The exposed structure behind the west gable on the seventh floor has a sculptural quality (Plate 4.14).

Windows on the tower cupola (Plate 4.15, 4.16, 4.17) and parabolic windows in the tower walls on the seventh floor provide even north light to the interior.
The geometric simplicity of interior details is applied to the cornice above the shop window and on the entrance steps. Some original details of services are still in place, e.g. a timber mask for electric cables at the level of picture rails, switches at the ground floor and a few ceiling hooks for lighting.

4.2.3 Structure

Regarding the condition assessment of concrete structures, it has been highlighted that although ultrasonic tests, covermeters, drill holes and other testing methods assist in the assessment, the results may be puzzling; and that the starting point in appraisal is knowledge of what is likely to be found at different dates and different types of structure.31

The innovative reinforced concrete structure of the Lion Chambers was presented in detail in an article published in January 1907, at the time when the work on the building was finalised. The article stated that the building had been constructed using the Hennebique system by the Yorkshire Hennebique Contracting Co. Ltd according to the structural design by L. G. Mouchel.32 Hennebique’s system used plain round bars with fish-tailed ends and stirrups of flat strips of mild steel.33 The stirrups provided shear resistance, although they were not mechanically anchored in the compression zone, as is the norm nowadays; column bars were linked by strips of wire.34 From

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34 Ibidem.
Concrete proportions by volume were approximately 1.1:2:4 of Portland cement:sand:coarse aggregate.\textsuperscript{38} The comments on testing and comparison with the design of concrete structures today assist in assessing the Hennebique system:

“The deflection criterion for passing a load test carried out on the completed structure was onerous by today’s standards. Under 1 ½ times the imposed load, the structure was not to deflect more than 1/600 times the span! It should, however, be born in mind that such structures were designed using elastic modular ratio theory, with permissible stresses typically of 16,000 lb/in\(^2\) (110 N/mm\(^2\)) in the reinforcement and of 600 lb/in\(^2\) (4.1 N/mm\(^2\)) in the compressed concrete. Consequently the section sizes and the reinforcement were more generous than a present-day design would require. A further factor – certainly for the floor slabs – is that the framing plans usually provided beams in two directions (on the precedent of iron and steel frames) The typical floor slab was accordingly supported on all four sides and, when loaded, would tend to behave more as a shallow dome in compression than as a slab in flexure, with beams acting both as supports and perimeter ties. Such behaviour would generate smaller deflections in the slabs.”\textsuperscript{39}

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|c|}
\hline
Form of tension bars & Form of compression bars & Form of shear reinforcement & Method of fixing shear reinforcement & Direction of shear reinforcement \\
\hline
Round straight bars and round bars bent up near supports & Round straight bars & Steel strip bent to U-shape and made with spring clip & Sprung on to tension bars and bent over for anchorage in concrete & Vertical \\
\hline
\end{tabular}
\end{table}

\textsuperscript{35} Ibidem.
\textsuperscript{39} Ibidem.
Hand-mixing was common, although mixing machines were also used. Mouchel’s specification called for 6 cwt (305 kg) of cement to be batched with 13 ½ ft³ (0.38 m³) of sand and 27 ft³ (0.76 m³) of coarse aggregate to give a 1.1:2:4 mix, with a probable cube strength of around 15-20 N/mm². Placing would be by spade or shovel and compacting by ramming, tamping or ‘punning’ by hand with a variety of tools including a rod with an enlarged box-end and another shaped like a hockey stick. The concrete was made wetter to ensure that it flowed more readily around the reinforcements. Reinforcements in concrete walls and foundations of the Lion Chambers were shown in the plans with the article published in 1907. The 42 vertical and 15 horizontal reinforcements built within the retaining basement wall to Bath Lane were presented in a cross-section drawing. This drawing also shows the cross-section of twelve foundation beams, with an axial distance of approximately 117 cm, below the retaining basement wall (Plate 4.19).

The east-west cross-section of the basement shows primary and secondary beams in the building foundation and ground floor. As this cross-section is through the centre of the plan, the beams’ size is reduced. This drawing also shows a cross-section through the inclined wall towards Hope Street where an opening at pavement level allows access of natural light to the basement through a thick semi-prism glass on a metal grid, and the view of natural light access to the basement from the glass roof in the south-east corner which is linked to the adjacent building’s basement (Plate 4.20, 4.21, 4.22).
Plate 4.21: Details of roof and roof windows

Plate 4.22: Details of the tower cupola
Three sections of retaining walls to Hope Street, Bath Lane and the back courtyard show reinforcements in the walls and a supporting inclined structure whose base is wider than its top. Other structural details also include reinforcing bars, e.g. the section through the corner oriel on Hope Street front; the cantilevered bays on Bath Lane; the roof next to Bath Lane with inclined slabs that provide access to natural light from the north into artist studios at the top floor; and the plan and section of the tower cupola. A plan of a bay window in Bath Lane shows a rectangular grid of reinforcing bars in the slab and the reinforced concrete columns with eight vertical bars and double horizontal braces around them. The original floor plans, completed in April 1905, indicate that the columns’ size is 10ins x 10ins and the thickness of the external walls 4 ins.\(^{43}\) A note on the cover of the set of drawings completed in 1905 provides some additional information on structure and services:

“1. All the constructional work of this building is to be of FerroConcrete by the Hennebique Co (The system adopted at Allie & McLellan’s New workshops Polmadie\(^{44}\)) and will be constructed to carry a safe superload on every floor of 1 5/8 cwt\(^{45}\) on each sq. ft.\(^{46}\) (the safe load is calculated at 1/5\(^{th}\) of the breaking strain). On completion and before occupying any part will be tested up to 2 cwt per sq ft and the deflection is guaranteed by the Hennebique Co not to exceed 1/600 of the span. The floor to practically recover itself on removal of the load.

2. There is a small Palmer’s travelling cradle to be used as a slaters’ scaffold so that the outside of walls & windows may be cleaned, pointed & painted with perfect security.

3. There are only two floors above 60’ from the street, the lower one containing two small 3 room offices and the upper 3 studios. There is a fireproof stair 4′ wide & a subsidiary stair 2’6″ wide (also fireproof), the latter leading up to roof. This building is entirely fire proof & inflammable materials are reduced to a minimum. The Palmer’s cradle could be used as a fire escape.”\(^{47}\)

As it was not possible to use outside scaffolding, the structure was built from within, floor by floor, enabling flying scaffolds to be cantilevered off each floor for outside work. Limited space also prevented the use of a concrete mixing plant, and the concrete was mixed by hand using the proportions ‘always employed for Hennebique work’\(^{48}\). Timber moulds were used for cornices. Plaster moulds reinforced with steel were used to form medallions, keystones and busts, but heavier decoration elements were cast beforehand and afterwards fixed in place.\(^{49}\) Cement mortar was used to render the fronta-
The Lion Chambers and the Teatro E. Duni

4.2.6 Contractors

The contractors for this pioneering work were for Reinforced Concrete Work, Yorkshire Hennebique Contracting Co. Ltd, Leeds; for Joiner Work, Geo. Laird & Son; for Plumber Work, Galbraith & Winton; for Painter Work, J. & J. Bottomley, Marsden; for "Mack" Partitions, Stuart’s Granolithic Stone Co.; for Bitumastic Enamel on Roof, Wailes, Dove & Co., Newcastle-on-Tyne; for Tile and Marble Work, Galbraith & Winton; for Heating Apparatus, Messrs. Combe & Son; for Electric Elevator and Enclosures, A. and P. Steven; for Electric Lighting, Claud Hamilton Ltd; for Lightning Conductor, Wm. Harvie & Co. Ltd; for Grates, Well Fire Co. Ltd; for Stoves, Carron Co.; for Modelled Ornament, Geo. Gregory; for Wrought Iron Work, Geo. Adam & Son; for Pavement Lights, Hayward Bros. & Eckstein Ltd; for Safe Doors, Donald Clerk & Son Ltd; for Ironmongery, J. L. Macindoe & Co. Consulting Electricians were J. E Sayers and Caldwell. Mr Alex McLay was the Clerk of Works. The pavement lights in Hope Street were installed by Hayward Bros. & Eckstein Ltd, a company based in London which patented “Improvements in Pavement Lighting” in 1871. Their system provided natural light to a basement through a thick semi-prism glass placed between T-shaped steel bars.

ges. The flat roof was constructed of reinforced concrete and covered with bituminous material except on the cupola and steep-pitched portions of the roof which were rendered with cement mortar. The anonymous writer of the article emphasised the attention given to building a very solid foundation ‘consisting of a general sill spreading the loads brought by the columns equally over the whole area of the site’.

‘Mack’ partitions separate internal spaces except next to the staircase whose walls were made of reinforced concrete. The partitions (plaster with embedded reeds) were built off-site by Stuart’s Granolithic Stone Co., the contractors who had experimented with reinforced concrete.

50 Ibidem.
56 Marsden is a large village in West Yorkshire, England
59 Claud Hamilton Electrical Services Ltd still operates in Bridge of Don, Aberdeen.
60 Carron Company had a warehouse at Port Dundas (c1830) and later in Buchanan Street. Hume, John R., The Industrial Archaeology of Glasgow, Blackie, Glasgow and London, 1974, p. 65.
4.2.7 Preservation actions

“I think there are many buildings in Glasgow in this situation – they are there, they are different, we all know them, but we often don’t have or take the time to find out about them. Then, just as we have the time to look and consider them, assess why they seem to stand apart and make difference, they become empty, fall into disrepair and are lost. This is a loss not only for the building’s owners and users, but perhaps more importantly, for ourselves – because the quality that made them stand out is gone forever. It no longer tells us its story, it no longer makes us stop and look, and it no longer makes us think.”, Raymond O’Donnell, 2003.63

The Lion Chambers’ uniqueness was recognised with the category ‘A’ listing in 1966.64 However, by the late 1980’s the building was in need of significant repair. In 1991, a report on the condition of the Lion Chambers and the adjacent building, with which it is connected, was provided to Historic Buildings Council of Scotland together with the application for a repairs grant.65 The report included information that a full structural survey had been submitted in March 1991 and that during the investigation temporary propping of the basement and ground floor had been installed. The structural survey showed that water penetration had affected the concrete structure and its reinforcement due to leaks from the roof, and that the defects in external walls had been aggravated by condensation. There was general deterioration of windows. The basement was affected by damp penetration and intermittent flooding. Carbonation of the concrete structure, resulting in severe corrosion of the reinforcement, was highlighted as the most serious defect, requiring major structural repairs in order to save the building and extend its useful life. Despite this, the structural report concluded that the superstructure remained stable.66 Other notes on the building’s condition in 1991 included comments that the lead on the cupola was slightly damaged; all other roof surfaces were covered with bituminous felt which was not in good condition; there were cracks in the render on all facades, but only hairline on the east wall which was re-rendered in 1978; patches of render were missing; there was widespread cracking on window sills on all elevations and at window heads on the rear facade. The structural damage was worst at the basement where “columns have split exposing severely rusted steel reinforcements and stirrups.”67

The 1991 report recommended removing render off all facades to identify and repair damage; repointing joints between the concrete frame and infill panels with epoxy mortar; carrying out alkali silica reaction tests on aggregate; protecting concrete from carbonation by either cathodic protection or re-alkalisation; and undertaking structural repairs. The report noted that windows on the north facade (in metal frames) were in better condition compared to timber window frames on other facades; some timber windows were replaced, but the

64 Statutory List, 168 Hope Street, Category A, Glasgow City Council, 06/07/1966.
67 Ibidem, p. 3.
The Lion Chambers and the Teatro E. Duni erected around the whole building and a protective mesh placed on the facades in autumn 1996. In autumn 1998, additional propping of the basement was installed, loose render was removed and broken windows sealed. In 1998, the structural survey noted further deterioration of building structure and fabric that extended to upper floors in which humidity increased without heating after they were left unoccupied. This survey concluded that due to the nature of the internal structure and the extent of carbonation, the previously considered methods of realkalisation of concrete were not applicable. The proposed options for interventions in the basement included replacing the external envelope and basement structure, and propping/retaining the interior; placing new watertight membranes to the concrete raft slab and retaining walls; stripping the plaster and repair of concrete surfaces; installing new skirting panels; making new corbels to column heads; and applying an overcoating treatment to all walls, columns and floor (400 microns of elastic coating). It was recommended to use Renderoc HB and Renderoc LA for the repair of concrete surfaces. A complete replacement of the external envelope was proposed by using 150 mm light weight concrete. Replacement of the first floor slab and all the columns from ground to roof level, and of the stairway on the south elevation was also proposed. Repair of roof surfaces and new weatherproofing was recommended, but no advice was given on thermal insulation. Window replacement, re-
pairs to internal finishes, services installation, upgrading electrical installation and new lift installation were recommended. It was suggested to re-render the rebuilt elevation, to use a protective membrane such as Dekguard “S” by Fosroc Expandite or similar, and to install an internal insulation/lining/vapour barrier to all elevations. A feasibility study, completed in 1998, proposed possible new uses of the Lion Chambers such as for offices, residential use or a design centre.

In May 1999, a press release was issued by Glasgow Preservation Trust pleading for financial support to save the Lion Chambers. However, Historic Scotland objected to the proposed reconstruction of external walls and suggested further research into conservation and repair techniques. In May 2000, a condition update report noted further deterioration of concrete elements at upper levels and continuing water penetration in the basement. There was also damage to the scaffolding which was hit by a vehicle. As the scaffolding around the building was unsightly and presented risks of vandalism and fire, it was decided to remove it and protect the facades with a galvanised steel mesh in 2000.

In February 2001, a feasibility study for the repair and conservation of the Lion Chambers, commissioned by Historic Scotland, concluded that additional propping of the structure was required in three other areas as the corrosion of the reinforcement had been internally exacerbated by the lack of use of the building, allowing high humidity levels to develop. As it was anticipated that the full repair would not be implemented for three years, temporary maintenance was required together with the installation of netting. Some localised demolition and reconstruction of parts of the structure were envisaged during the full repair. The proposed repair solutions focused on the control of moisture within the concrete and included demolishing and recasting extensively deteriorated structural members at roof level, within the basement and the escape stair; external and internal patch-repair of damaged concrete using a concrete repair mortar matching the original constituents and including non-shrink additives; strengthening critical beams using carbon fibre bonding to improve floor loadings; repair of external render using a mix of similar proportions to the original and an application of a proprietary elastomeric coating; installing a sacrificial anode system to high risk basement columns and beams; excavating pavements to expose outer faces of basement walls and applying waterproofing externally; and installing temporary air conditioning to dry out the structure. It was recommended to trial corrosion inhibitors and/or electro-osmosis on the structure.

The report also examined potential future uses in relation to Building Standards and concluded that extensive strengthening would be required in order for it to be acceptable for the office loading in line with current practice, but noted that the level of strengthening required to meet
an imposed load 2.5KN/m² would be extensive and disruptive. Reduction of the imposed loading requirement to 1.5 KN/m², equivalent to domestic use, would significantly reduce the extent of likely strengthening and make carbon fibre bonding a feasible solution. However, it was suggested that due to the building age, a full scale load tests might be required to estimate the floor loadings for a change of use.\textsuperscript{83} The report also discussed thermal insulation that would be needed to satisfy requirements for fuel conservation indicating that it was theoretically possible to insulate the walls leaving a vented void (to eliminate moisture from external walls) around the internal face of the external walls. This solution would entail reducing the size of rooms and increasing the dead load. Another suggested option was to use relatively thin and lightweight proprietary products, with a comment that it was unlikely that building regulations would be met in this way. The conclusions were that a higher level of heating would be necessary than normally expected to provide a modern living environment.\textsuperscript{84} During this research in April 2011, the vacant building was inspected and tests on the reinforced concrete columns were undertaken. However, destructive investigation holes have not been reinstated to prevent deterioration around them. An external protective net prevents damaged render pieces from falling, but does not prevent further deterioration of the facades from weather (Plate 4.23). Condensation impact on wall and ceiling surfaces is clearly visible (Plate 4.24).

The basement is in the poorest condition. Water penetration has damaged the bases of columns (Plate 4.25).
4.2.8 Assessing the condition of reinforced concrete and selecting appropriate repair options

The following section provides a brief overview of the causes of deterioration of reinforced concrete and repair options. The causes of deterioration of reinforced concrete can be assigned to inadequate design, construction, materials and maintenance.\(^\text{85}\) Design aspects include the consideration of the likely exposure conditions, the correct mix, more than 15mm concrete cover to the reinforcing steel, and the provision of sufficient movement joints of appropriate dimensions and location. Construction faults occur if the concrete is poorly compacted, inadequately cured, does not provide a sufficient cover to the reinforced concrete, or has a high porosity due to the addition of too much water. Materials such as calcium chloride, alkalis that instigate alkali-silica reaction and iron pyrites among the aggregates could cause deterioration of reinforced concrete structure. Lack of or inadequate maintenance (e.g. by using epoxy resin mortars) can reduce durability of reinforced concrete.\(^\text{86}\)

Corrosion of steel reinforcement in concrete can occur due to carbonation of concrete or attack by chlorides. Carbonation is caused by penetration of carbon dioxide into the concrete and reaction with alkaline calcium hydroxide which results in formation of calcium carbonate and water. Atmospheric carbon dioxide can only react with the cement hydrates when there is sufficient pore water to first dissolve it.\(^\text{87}\)

The rate of carbonation increases with temperature, carbon dioxide concentration and porosity.\(^\text{88}\) The reduction of alkalinity of cement damages the passivating (protecting) layer on the surface of reinforcement bars and enables corrosion. Carbonation starts at the concrete surface and penetrates faster if the porosity of concrete is high and the atmospheric humidity is between 50% and 75%. Carbonation slightly increases compressive strength of concrete, but has a negative impact on the protection of the embedded reinforcing steel.\(^\text{89}\)

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\(^\text{86}\) Ibidem, 105.


\(^\text{88}\) Ibidem, 3.

the concrete becomes carbonated, it is likely that the steel surface will produce rust whose volume is ten times bigger than the steel it replaces, causing the cracking and spalling of the concrete cover.\textsuperscript{90} The concrete condition survey should entail a careful cross-correlation of the results of a cover meter survey (to assess depth of cover of steel reinforcement) with the results of carbonation depth testing to enable accurate identification of all locations where reinforcing steel is actually in contact with carbonated concrete. If there is no reinforcing steel in the carbonation zone, there is no need for removing carbonated concrete.\textsuperscript{91} Renders and tiles are more reliable than painted coatings in minimising the rate of carbonation.\textsuperscript{92} Chloride can also destroy the protective layer on reinforced concrete. Chlorides can remain on poorly washed sea-dredged aggregates, or could come from de-icing salts or from exposure to sea salt spray or sea water. The content of chloride ions in concrete below 0.2-0.4 % is considered safe, but above 1.0 % represents a high risk of corrosion. Surface-applied corrosion inhibitors are recommended when repairing listed structures as they penetrate concrete and act directly on the steel reinforcement to inhibit the corrosion process and may reduce the need for an overall coating treatment.\textsuperscript{93} The concrete itself can degrade due to sulphate and/or acid attacks. Aggregate can degrade due to alkali aggregate reaction (AAR) in which the alkali in cement reacts with the aggregate to produce an expansive gel that causes the concrete to crack, typically in three-legged crack form.\textsuperscript{94} The risk of corrosion is increased when the resistivity (a measure of resistance to the passage of current) of concrete is low. When the resistivity is high, > 12 k\(\Omega\) cm, the resistance to current flow is high and the rate of corrosion is minimal, but if the resistivity is low, < 5 k\(\Omega\) cm, a high rate of corrosion can occur.\textsuperscript{95} As the relative humidity content of the concrete increases, its resistivity decreases.\textsuperscript{96} If the relative humidity is below 60-70% RH, corrosion will not normally occur.\textsuperscript{97} The risk of corrosion is also increased if the concrete exposed to atmosphere is subjected to cycles of wetting and drying.\textsuperscript{98} The application of coatings and surface treatments can be highly effective in limiting or preventing degradation.\textsuperscript{99} The limitations of patch repairs, particularly with respect to chloride attack, have instigated the development of other approaches to repair.\textsuperscript{100} As the corrosion of steel is an electromechanical process that results in the formation of anodic and cathodic sites on the surface of the steel, the metal is dissolved at the anodic side while the cathodic side remains unaffected. If

\textsuperscript{90} Ibidem, 109.
\textsuperscript{91} Ibidem, 110.
\textsuperscript{93} Ibidem, 113-114.
\textsuperscript{96} Ibidem.
\textsuperscript{97} Ibidem.
\textsuperscript{98} Ibidem.
\textsuperscript{99} Ibidem.
\textsuperscript{100} Ibidem, 121.
a small externally generated current is applied to the steel, all the steel can become cathodic and non-corroding.\textsuperscript{101} As the design of cathodic system has to take into account many variables (e.g. the aggressiveness of the environment, the area of steel to be protected, the resistivity of the surrounding material, the positioning of any external metallic objects that could be affected by the system, and the type of anode used), it has been suggested that the initial design requirements and the application of a current throughout the service life of the structure can make cathodic protection more expensive and complex than other repair options.\textsuperscript{102}

As the alkaline concrete environment that protects steel reinforcement can be changed by the acidic reaction with carbon dioxide (carbonation), the electrochemical technique of re-alkalization can be used to restore the alkaline environment.\textsuperscript{103} Following the re-alkalization intervention, the concrete surface is coated with an anti-carbonation coating. The advantage of the technique is that the disruption can be kept to a minimum.\textsuperscript{104} Chloride extraction is the electrochemical technique used for desalination of concrete.\textsuperscript{105}

Water repellents based on organic silicon compounds are protective coatings that enhance durability of new and existing reinforced concrete structures without significantly altering the appearance of exposed concrete, which is of interest for repairs of listed structures.\textsuperscript{106} Spray-applied cementitious materials with low resistivity are specified for use in major reinforced concrete repair programmes.\textsuperscript{107}

A recently developed electro-osmosis system for controlling moisture levels in new and existing reinforced concrete structures is capable of reducing moisture levels in concrete to between 60% and 70% RH and maintaining this level independent of external weather conditions.\textsuperscript{108}

Regarding listed structures of reinforced concrete, identification and eradication of the cause of the damage is crucial for long-term conservation.\textsuperscript{109} However, there are still no unambiguous guidelines available on how to approach the investigation or repair of damaged reinforced concrete buildings, whether listed or not.\textsuperscript{110} Historical information should be gathered on how and why a material is used, changes to the concrete, its environment and function during its history, changes in chloride levels, levels of carbonation and any changes in the chemical and physical characteristics.\textsuperscript{111} Categorizing the problem (e.g. structural, durability, moisture, drainage, safety, social, cosmetic or aesthetic), establishing its cause, extent and likelihood of continuing, identifying effectiveness and side effects of previous repairs assist in directing the investigation process.\textsuperscript{112} A thorough physical investigation should

\textsuperscript{101} Ibidem.
\textsuperscript{102} Ibidem.
\textsuperscript{103} Ibidem, 122.
\textsuperscript{104} Ibidem.
\textsuperscript{105} Ibidem.
\textsuperscript{106} Ibidem, 123.
\textsuperscript{107} Ibidem, 125.
\textsuperscript{108} Ibidem.
\textsuperscript{110} Ibidem, p. 130.
\textsuperscript{111} Ibidem.
\textsuperscript{112} Ibidem, p. 131.
The most appropriate and practical technical solution will be used to reinstate the building strength, function and durability, and to allow appropriate maintenance. The capital and life-cycle cost of the repair, the cost of disruption during the repair, and value added by the repair should be considered in the evaluation of economic aspects. Conservation aspects such as the use of original materials for repair and the retention of the original design and appearance should be considered for the repair of listed buildings. Social aspects such as health and safety requirements during the repair and the perception that the building will be improved in long-term by removing the cause of the problem through the repair should be considered. It has been suggested that it is unlikely that any one of repair options would be sufficient on its own and that the most appropriate would probably be a combination of more than one (Table 4.26).

The above list is a useful exercise in decision making regarding the presented or any new repair methods which have been developed, particularly over the last decade, that can reinstate or enhance the durability and performance of existing reinforced concrete structure while allowing the original structure to remain relatively intact. Another tests were performed on reinforced concrete structure in April 2011 (See Chapter V).

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113 Ibidem, p. 132.
114 Ibidem.
115 Ibidem, p. 133.
117 Ibidem.
119 Ibidem, p. 135.
120 Ibidem.
<table>
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<tr>
<th>Repair Option</th>
<th>Anticipated maintenance-free service life</th>
<th>Advantages</th>
<th>Disadvantages</th>
<th>Level of intervention</th>
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| 1             | No action (do nothing) Less than five years | • cheapest short-term solution – no capital outlay  
• no access required, no pollution or disruption to site  
• no conservation problems | • deterioration will continue at accelerating rate  
• structure becomes unsightly and eventually structurally unsound, service life of structure will be limited  
• unlikely to be the most cost-effective long-term solution | None, but safety checks would be required. |
| 2             | Traditional repairs with no coating At five-yearly intervals throughout the service life | • cost-effective short-term solution (repairs can be colour and texture matched)  
• minimal scaffolding/access required  
• minimal ongoing maintenance required  
• limited disruption to site | • will not prevent deterioration in the structure elsewhere  
• corrosion damage continues and further repairs will be required (in say five years)  
• may not provide the most cost-effective long-term solution | Not often if carried out correctly, but adjacent areas would need to be checked. |
| 3             | Traditional repairs with a coating At five to ten-year intervals throughout the service life | As above | As above  
• almost all coatings will alter appearance  
• coating will not prevent ongoing corrosion if the carbonation has progressed to reinforcement level or if chloride levels are above threshold levels at reinforcement | As for 2 above, but also at end of coating service life (dependent on type of coating). |
| 4             | Traditional repairs followed by electro-chemical realalkalization with no coating Ten to twenty years | • one time fix solution  
• after application, no further maintenance or monitoring required  
• minimal alteration to appearance  
• well-documented and proven technology  
• can be most cost-effective long-term solution  
• process re-established corrosion protection properties of the concrete to protect steel reinforcement  
• minimizes amount of carbonated concrete to be removed | • repair mortar for patching must be compatible with realalkalization process (limits manufacturers and products)  
• higher capital costs  
• carbonation and chloride ion ingress will recommence, albeit at a slower rate  
• fairly extensive clean-up operation required to remove materials used in realalkalization process  
• some concretes may contain reactive aggregate (AAR), which needs to be determined prior to alkalization | At approximately ten-yearly intervals if carried out correctly |
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4.2.9 A proposal for restoration interventions

The following section indicates the actions for eliminating the causes of deterioration of reinforced concrete structure in Lion Chambers and proposes interventions that could increase the building sustainability. Water penetration into the basement has to be prevented. Excavation around the basement walls will enable inspection, installation of drainage next to the foot of the foundations and waterproofing of the external surfaces of the basement walls. As excavation around the building has to be undertaken, there is an opportunity to install a ground source heat pump before the excavated area is filled with soil. Internal thermal insulation of basement walls and floor would improve energy efficiency.

As the prism glass on T shaped iron beams along the top of the south basement wall were covered with asphalt, they need to be restored to provide natural light to the basement. The glass roof in the basement space connected with the adjacent building should be restored and protected from vandalism, e.g. by a strong steel net above the roof. Heat recovery mechanical ventilation could be installed in this area to provide continuous ventilation of the basement.

Waterproofing layers on the building roof need to be removed to inspect the roof surface and repair any damage. Thermal insulation on the external surface of the roof should be installed and protected before installing waterproofing materials. The lead cover of cupola should be removed and the cupola surface covered with thermal insulation which should be protected from water penetration before the new lead or aluminium cover is installed. If the cupola does not have thermal insulation, condensation could form on its internal surface in cold weather as warm internal air carries vapour up. On the inclined sections of roof, on the south side of north-facing roof windows, hot water solar panels could be installed to top up hot water obtained from a ground source heat pump for heating. These roof surfaces cannot be seen from the street level.

Water collection from the roof could be considered by installing a water tank which might be placed within the space which also houses the elevator mechanism at roof level. As suggested in previous building survey reports, the building structure should be dried before any repair work on its surfaces is undertaken.

Along with natural ventilation, mechanical heat recovery ventilation should be provided in rooms that do not have windows. In order to prevent condensation on internal surfaces of the external walls, an appropriate thermal insulation should be installed. As the aim of the restoration of elevations is to preserve and restore the original appearance as much as possible, consideration should be given to thermal insulation materials which have high insulating properties and low thickness, and renders with thermal insulation properties.

Windows with high thermal insulation properties, high airtightness and adequate appearance (e.g. double glazed windows with narrow space between the glass panes) should be considered. As the evidence on the shape and design of the original windows is available from old photographs, they can be restored. Research on the interior design should be undertaken to preserve original details such as the bright green wall tiles in the entrance hall and other details that can be preserved during the adaptation for new use. High quality inte-
The Duni Theatre was the first public work designed by Stella and it was done with enthusiasm for his town. This was the first work built entirely in reinforced concrete in Matera. The young architect was aware of the construction difficulties with this new material, above all for the Materan workers who, although experts in working with tufa, had little or no experience working with reinforced concrete. With the realisation of the Duni Theatre, a decisive change was made regarding the public architecture of the city; through all of this, from economic investments, the choice of the planner, the application of new building techniques, to the use of materials and the availability of local workers, a new cultural condition for the city was created.

The project (Plate 4.26, 4.27), ambitiously conceived as a cinema-theatre with adjoining hotel, was presented in August of 1946 for approval to the Municipal Building Commission. The detailed project was drawn up between October 1946 and February 1947, in collaboration with the Materan architect Salvatore Mascianardo. Construction began in the spring of 1947 under the direction of Stella and the engineer Vigliar, who was commissioned to work on the project and to do structural calculations. The construction was entrusted to the Materan enterprise of the Morelli Brothers. The building pro-

4.3 The Duni Theatre - Matera (Italy)

4.3.1 Social and cultural context

Right after the war, the town of Matera went through a period in which it really aspired to modernize and evolve itself towards more civil living conditions. In this context, two private citizens, the typographer and editor Cav. Carlo Conti and the lawyer Domenico Latronico, commissioned a young Materan architect, Ettore Stella (see Chapter II), in the summer of 1946, to realise the project for a cinema-theatre with adjoining hotel, to be situated in the downtown area of the city, between via Roma and the back of the 18th century via Lucana.

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Plate 4.26: Plan of Theatre Duni

Plate 4.27: Longitudinal section of Theatre Duni

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