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Knowledge Transfer in the Nineteenth Century: The Short History of *béton aggloméré* in Queensland

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Abstract

This paper will revisit Brisbane during the second half of the nineteenth century; a time when technological innovation was perceived as essential to the economic prosperity of the newly proclaimed colony of Queensland, and individuals sought opportunities to make good through its operation. It will investigate early concrete technology in Queensland and specifically the contribution made by Charles Lambert Depree (c.1845-1893), an engineer and surveyor educated at King's College, Cambridge, whose interest in concrete was triggered during his time in France working on a patented process for coppering iron armour-plated ships. Depree, who arrived in Brisbane in 1869, is credited with introducing concrete into the colony of Queensland. His legacy, a concrete house 'Goldicott,' constructed using pise *technology, is an exemplar of a moment in time when concrete was poised between its craft origins and its potential as a modern industrial material.*

Queensland does not feature greatly in generalist accounts of technological innovation in relation to architecture in Australia. Henry Cowan's (1998) portrayal of technology in Australia mentions Queensland only in relation to its timber 'style' of construction. In Miles Lewis' 200 Years of Concrete in Australia*, concrete innovation within the Queensland Railways and Mines and Works Departments is noted in relation to the achievements of H.C. Stanley and A.B. Brady. Yet Donald Watson and Judith Mackay in their seminal work,* Queensland Architects of the 20th Century *report that Charles Lambert Depree was a significant figure in the innovative use of concrete in Queensland and Australia. This paper investigates the circumstances surrounding his contribution.*

In *Concrete and Culture: A Material History* (2012), Adrian Forty writes of the abstruseness of concrete – a material formed simply by mixing cement, water, sand and aggregate:

> In so far as concrete came out of the speculative research of industrial chemists, it was a 'modern' material; likewise, in so far as it developed through the impetus of entrepreneurs to market cement, it was 'modern;' but in so far as it was a product of messy hit-or-miss experiments of tradesmen and contractors on the building site, it was wholly non-modern.[1]

It is this characteristic of concrete, of being poised between modernity and primitiveness, that enables the historian to see 'into 'a fugacious world of beliefs and counter beliefs, hopes and fears, longings and loathings'[2] and to identify the social and cultural, political and economic circumstances of its making. The story behind 'Goldicott,' a concrete villa built by Charles Lambert Depree (1845-1893) in 1885 in the village of Toowong, now a suburb of Brisbane, provides insight into the political and economic circumstances of the newly formed colony of Queensland. Queensland's first leaders perceived that infrastructure, in particular the railway was essential to survival of the financially precarious colony and that technological innovation was the means to address the colony's extensive and difficult terrain.[3] Innovation in Queensland is tied to the arrival of engineer emigres, armed with the most current knowledge and expertise, and keen to 'make their way' in the colonies. Among this group was Charles Lambert Depree, engineer, surveyor and architect of Goldicott, who Donald Watson and Judith Mackay in *Queensland Architects of the 20th Century* (1994) identify as a significant figure in the innovative use of concrete in Queensland and Australia.[4] Other generalist accounts of technology in Australia fail to mention Depree in relation to innovation in either architecture or engineering. This paper describes the circumstances surrounding Depree's contribution in order to establish its significance.

***Béton aggloméré* in France and England**

Peter Collins' *Concrete: the Vision of a New Architecture: a study of August Perret and his precursors* (1959), which focuses on French innovation to contextualise a study of Auguste Perret, architect and contractor, has, until recently been considered as received wisdom on the origins of concrete. It is only since the end of the 20th century that historians including Pedro Guedes, Cyrille Simonnet and Adrian Forty have examined other centres of experimentation - in England, the United States and Germany – to acknowledge the

development of concrete as haphazard, opportunistic and 'dispersed' across classes and professional groups:

> chemists and engineers who developed cements, industrialists whose prime interest was in the commercial exploitation of cement production and ordinary builders who by trial and error on the building site, developed the practical application of the material and subsequently the technique of reinforcing it with steel.[5]

France's tradition of systematic enquiry was critical to the development of concrete[6] and Collins' account provides a window onto France in 1868, when the young English-trained engineer, Charles Lambert Depree was working on a patented process for copper plating iron armour for ships.[7]

Collins traces a line of inquiry from *pise* construction techniques[8] through Jean-Baptiste Rondelet (1743 – 1829) who used mortar to bind pise material; Joseph-Louis Lambot (1814-1887) who experimented in artisanal fero-cement horticulture products; Francois Coignet (1814-1888) who patented ways to industrialise concrete production; Joseph Monier (1823-1906) and François Hennebique (1842-1921), who separately patented reinforced concrete systems. He observes that innovation in France in the nineteenth century, was constrained not by a lack of invention but of opportunities for 'exploitation and experiment.'[9] This is confirmed by Forty who, citing Simonnet (2005), notes that although knowledge was in the hands of industrialists chemists and engineers, 'the actual work of constructing in concrete remained in the hands of small contracting firms using traditional skills.'[10]

Françoise Coignet, inventor, chemical manufacturer and wealthy industrialist, possessed both the finance and the materials and equipment necessary for experimentation. Coignet also understood the value of the patent system for creating an industrial monopoly. The construction of a new factory in St Denis in 1851 using a *pisé de terre* system provided Coignet with the opportunity to experiment with different aggregates, proportions and consistencies of mixture. A second experiment, a promotional house at 72 rue Charles-Michels, Saint-Denis followed in 1953.[11]

Coignet adopted the term *béton agglomeré* to describe his process.[12] *Béton* has its roots in the Old French word *betum* meaning 'a mass of rubbish on the ground' and *agglomeré*, compacted. He took out two patents in France titled *Béton Economique* and *Emploi de*

Béton in March 1855,[13] and one in England in November 1855.[14] In the United States, his process became known as *Béton Coignet* and was used in concrete blocks and in-situ constructions.[15] In 1955, he built the stationmaster's house at Suresnes, which became the subject of a lecture given at the French Institute of Civil Engineers in 1859. He published a text *Bétons Agglomérés appliqués a l'Art de Construire*,[16] and in 1861 established himself as a building contractor under the name *Société Centrale des Bétons Agglomérés*.[17]

Coignet's 1859 lecture to the French Institute of Civil Engineers was reported in a review published in *The Builder* on 2nd July 1859,[18] and Collins believes that it is through this report in *The Builder* that a Mr B. Herschel Babbage in South Australia gained the knowledge that enabled him to erect Australia's first concrete house.[19] Babbage, in turn, reported on his house in *The Builder* in 1860,[20] promoting concrete's use in remote locations, its economy, buildability, especially in the absence of skilled labour, comfort, fire resistance and defensibility;[21] the same characteristics of concrete that Depree would later also promote.

Coignet had his commercial eye on the potential of concrete's industrial scale usage, and his monopoly in Paris extended to the construction of the retaining wall to the Passy Cemetery, the Boulevard de l'Empereru and the 'Aqueduct de la Vanne' (1867-74) and other key elements of Haussmann's Paris. Another influential character, English building contractor Joseph Tall, was conscious of concrete's reliance on craft practices. Realising that most of the expense of building in concrete lay in the timber formwork, he devised and in 1864 patented a demountable and reusable shuttering system.[22] When local contractors, who risked being locked out of production, pointed out that the patented system was nothing more than what was required by conventional *pisé* construction, Tall claimed that he was 'only seeking an "improvement."'[23] Tall's Patented Shuttering was used under licence on projects in France including for the construction of a large number of workmen's dwellings in Paris – a project commissioned by the Emperor Napoleon III which was awarded the gold medal at the 1867 Paris Exhibition where it was exhibited alongside Monier's reinforced horticultural pipes and a concrete pavilion by Coignet.[24]

Although there was widespread experimentation with iron rods and straps, Joseph Monier and Francois Hennebique had not yet patented their most significant innovations in reinforced concrete when Depree left Europe in 1869 for the colony of Queensland.[25] Depree may not have visited the 1867 Exhibition, but he would have been aware of work by Coignet's firm,[26] and would have been fully apprised of concrete's capacity as a mass-material, its mould-ability, and the mechanisms for its industrial scale use. There are sufficient correlations between events in Coignet's career and those in Depree's to suggest

that in migrating to the colony of Queensland he hoped to 'make good' as a contractor in concrete, in a manner similar to Coignet.

Le béton in the colony of Queensland

On arriving in Queensland in 1869, armed with testimonials and letters of introduction,[27] Charles Lambert Depree sat the Government examination and qualified as a Crown Lands Surveyor. Soon after, he opened an office as a Civil Engineer and Surveyor.[28] However, there was little public work available in the financially precarious colony of Queensland. Like Coignet, Depree began a demonstration project – a concrete out-building adjacent to his family home, Mecklenburgh Villa, Fortitude Valley. Adopting terminology used by Joseph Tall, he lodged a patent in Queensland titled 'Certain improvements in the mode of building in concrete' in November 1871. Letters of Registration dated 11 February 1872 refer to 'specifications therewith annexed.' These 'specifications,' which share similarities with English patented systems,[29] were not included with the archived patent documents. An undated drawing depicting this 'improvement' was discovered archived with railway drawings[30] and titled as 'Sketch of Mr Dupree's (sic) patent framework for building concrete houses' (Figure 1). That this drawing was discovered with railway drawings, suggests that Depree did or was intending to construct concrete railway structures or buildings in the manner of Coignet at Suresnes, for by 1872 he was working with the Queensland Railways.

The drawing depicts a very straightforward reusable timber shuttering system, described by Depree as follows:

> The apparatus employed in building is remarkably simple in construction and in use and consists chiefly of uprights and frames of timber. The uprights are bolted together in pairs at a distance apart equal to the thickness of the wall be built and these are then placed at intervals of a few feet all around the site of the walls. Moveable frames are then placed in position connecting them, and the concrete, carefully mixed, is filled in between them. The frames are allowed to remain for one or two days, and are then moved upwards and the process repeated.[31]

Between 1872 and 1875 Depree worked on the extension of the Main Line railway from Ipswich to its Brisbane terminus at Roma Street Station and between 1875 and 1877, after the discovery of tin near Quart Pot Creek, he was Resident Engineer for the working survey of the Warwick-Stanthorpe Railway.[41] Queensland State Archives have in a listing titled 'Albums of Employees of the Chief Engineer's Branch' a folio of *Photographic Views Illustrative of Recent Railway Construction in Queensland* (1882), which features almost exclusively infrastructure completed on the Warwick to Stanthorpe line during the period Depree's was engineer responsible for the working surveys. These include concrete arched culverts with 1.8m and 3m spans, one of which was still in service at the time of publication of Miles Lewis' history on concrete in Australia,[42] and a concrete dam used to supply water to the locomotives. Also constructed on the line were two tunnels with concrete lined walls and brick arched ceilings. These projects quickly demonstrated the capacity of concrete to circumvent problems of regular flooding.

Between 1878 and 1880, Depree was District Engineer in charge of Railways in Maryborough, a major port and point of entry for immigrants to Queensland. Watson and Mackay report that his appearance in towns throughout the Wide Bay region was welcomed as a precursor to the coming of the railway.[43] In 1886, Depree was appointed Assistant Engineer-in-Charge of the Southern and Central Division of the Railway Survey Branch, supervising drawing office staff and answering only to Chief Engineer H.C. Stanley.[44] At this time, the Main Line was extended from Roma Street Station to the newly constructed Central and Brunswick Street Stations. This involved the construction of two tunnels, the first from Roma Street to Central opened in 1889 and the second and also the longest, to Brunswick Street opened in 1890.

In 1885, Depree constructed 'Goldicott'[45] in Toowong on land he had fortuitously acquired freehold title to ten years earlier in 1874, shortly before the opening of Toowong railway station on the Brisbane to Ipswich railway line in 1875[46] (Figure 3). 'Goldicott' sits at the end of a spur of land in the foothills of Mt Coot-tha and in 1885, commanded a 360 degree view to the hills, river and distant town. It remains the most prominent of prestige addresses in Toowong and is a demonstration of Depree's ambition.

Toowong in the 1860s and 1870s was a 'fashionable, new' suburb and home to some of Brisbane's most distinguished citizens including premiers, members of the judiciary and legislative assembly, architects William Henry Ellerker, F.D.G Stanley and Richard Gailey and Depree's own supervisor, Henry Charles Stanley.[47] Villa suburbs like Toowong, which

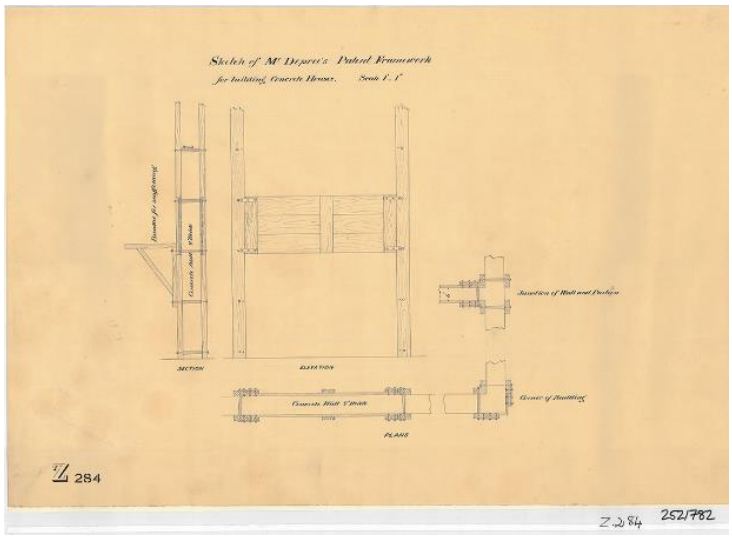

Figure 1. Drawings – Railway. 'Sketch of Mr Dupree's (sic) patent framework for building concrete houses.' (Source: Queensland State Archives. Item ID: 2521782. Series ID: 17687.

Depree's concrete out-building attracted much attention and led to his being engaged as a contractor on a number of government contracts including the male and female refractory wards at Woogaroo Asylum (Goodna).[32] An extant architectural plan of the Refractory Cells contains the following note: 'Note 2 buildings to be built to this plan one for males ... one for females' (Figure 2). Plans indicate a mass wall construction although the dimensions of the two wall thicknesses (14 inch external walls and 9 inch internal walls) are consistent with either concrete or brickwork. Wall surfaces are scoured to resemble stone, a means of rendering concrete typical in England at this time.[33] *Grace's Guide to British Industrial History* claims the contract for refractory cells was 'most satisfactorily carried out,' suggesting this drawing is related to Depree's project.[34]

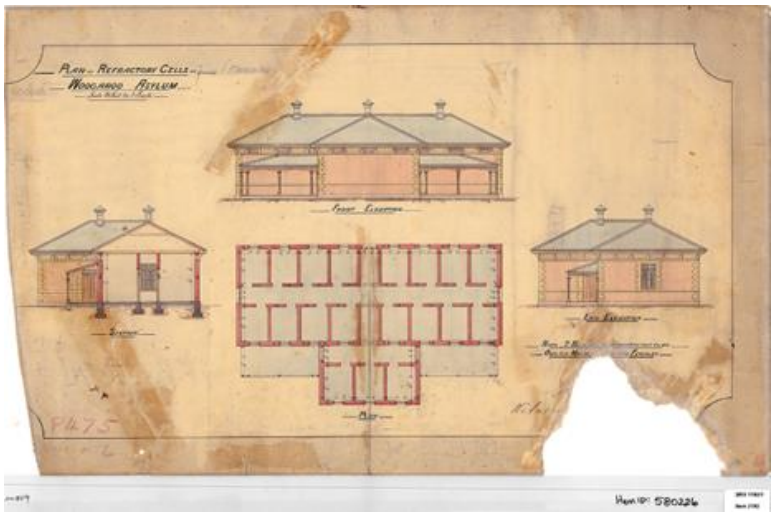

Figure 2. Architectural Drawing. 'Plan of refractory cells at Woogaroo Asylum' (Source: Queensland State Archives. Item ID.580226.)

Grace's Guide also claims that Depree was engaged to work on the first and smaller of two underground reservoirs, the Service Reservoirs, built in 1871 on Wickham Terrace then known as Windmill Hill. The Service Reservoir's Heritage Citation records the following information:

> Tenders were called in 1870 for the construction of a reservoir in either concrete or brick. Henry Holmes' tender was accepted specifying the use of concrete, but after preliminary excavations and the identification of cracks in concrete samples, Holmes requested to change the walls to brick and subsequently offered to withdraw his contract. The Board of Waterworks made the decision to complete the contract under its own Clerk of Works; immediately letting a contract for bricklaying and purchasing 69,000 locally produced bricks.[35]

However, there is little else to confirm Depree's involvement with this project. Ultimately, concrete work on the Service Reservoir was limited to the cement rendering of a small portion of the interior walls.

A lack of funding for public works may have been the trigger for Depree taking a position with the Queensland Government in July 1871. Depree was appointed Assistant Engineer on the Southern and Western Railway working under the direction of Chief Engineer Henry Charles Stanley.[36] He was well prepared for this new role, having been articled to work on the Kidwelly Branch of the Carmarthen and Cardigan Railway, a rail line passing through difficult terrain in South Wales.[37]

The significance of railways to the Queensland's economy cannot be underestimated. Historian A.E. Cole notes that two-thirds of the colony's produce travelled down the Main Dividing Range from Toowoomba to Ipswich at this time on mud roads: 'a risky and expensive journey' that could take two weeks to complete.[38] 'It was no uncommon circumstance for 100 drays to be detained waiting for the possibility of travelling.'[39] After years of recession, false starts, arguments over gauge sizes, bad press, appropriation bills, and unpaid contractors and labourers, the line to Toowoomba opened to traffic on 12 April 1866. It was devastated the following year though flooding; flooding immediately registered as a seasonal risk shaping the future expansion of railways in Queensland.[40]

developed in Australian colonies close to major towns, were modelled on a similar concept in England: 'conscious, but miniature, imitations of the landed estates of the old aristocracy.' They were inhabited by the affluent middle class, businessmen, professionals and civic leaders who 'needed to be within reach of the cities but preferred not to live in them.'[48] Early Brisbane town was plagued with poor sanitation, unreliable water supply, and outbreaks of typhus fever, whereas Toowong had been compared favourably with the dales of Devon. Extensive gardens featured ornamental trees, citrus and roses, tennis lawns, terraces with dry-stone walling.[49]

Depree promoted Goldicot in an article in the *Brisbane Courier* "Concrete Buildings:"

> The house is of considerable size, about 50ft x 50ft, with 10 ft verandahs and the walls both internal and external (15ft in height) are built entirely of concrete, as are also the piers for wall plates ext. The outer walls are 9in in thickness and the inner ones 6in. The stone is composed of broken stone, sand and Portland cement. The stone, a kind of greenstone strongly impregnated with quartz, is obtained on the ground.[50]

Figure 3. Mount St. Mary's, previously "Goldicott." (Source: Heritage Register, Heritage Branch Staff.)

The article continues, describing 'the apparatus' depicted in Depree's 1871 patent drawing and also describes the practical advantages of concrete over brickwork using many of the same points that Babbage noted 20 years earlier:

> …. it is somewhat cheaper than brick, and superior to it in imperviousness to heat and damp and also to sound. The work can be carried out but with little

> skilled labour, a carpenter only being required to supervise the erection and shifting-up of the apparatus…. It is especially desirable where white ants are so destructive….[51]

The concrete exterior walls on the veranda of 'Goldicott' are rendered and lineated in imitation of stonework. Other external faces are plain rendered. Full length bay windows with timber framed sash walk through windows opened onto the veranda. The entrance hall was lit by a gas lamp, using gas reticulated along nearby Sherwood Road. In 1992 the house was refurbished revealing a full-length hand painted mural on the walls of the entrance hall.[52] Frescos were common in the houses of rich Lyonnainse traders, whose country estates were frequently constructed in *pise* and decorated using frescoes to 'conceal(s) from the spectator's eye the nature of the building material.'[53] Depree's mural replaces classical scenes common to villas in France with scenes of wading birds and grasses, found along creeks in the Milton Reach of the Brisbane River.[54]

As a prototype, Goldicott was not a huge success. Brick and stone were the traditional symbols of wealth and prestige, not concrete,[55] as Forty citing a 1876 article in *The Builder* observes: 'There is an undoubted prejudice against the look and even the feel of Portland Cement.'[56] Whilst aspiring to be progressive in other ways, Brisbane's growing professional and elite class sought to imitate the homesteads of landed gentry, and despite timber being described as the traditional mode of construction in Queensland,[57] villa estate houses were frequently built in brick and stone. Brick estate houses adjacent to Goldicott in Toowong included William Ellerker's 'Dovercourt Cottage' (c.1864),[58] Walter Horatio Wilson's 'Sherwood Grove' (c1866),[59] and F.D.G Stanley's 'Sidney House' (1882) for Thomas Finney.[60]

Depree's house is caught between the origins of concrete in craft practices and its modern potential. Depree did not explore the material character of concrete, which in Goldicott is hidden with renders, paints and wallpapers. He did not experiment with reinforcing by inserting pieces of mesh or iron, a practice common amongst builders and contracting firms in Europe that led to a surge in patented systems at that time.[61] Nor did his *pise* construction method progress concrete's potential for modern industrialised production. Instead, Depree appears concerned with finding a market for his system within the small and conservative setting of Brisbane.

The earliest railway bridges in Queensland were low-level bridges constructed of timber or steel trusses. Reinforced concrete was realised first in road bridges in Queensland and

architect and engineer Alfred Barton Brady (1856-1932) who arrived in Queensland in 1884, is most associated with its development. Brady's Gairloch Bridge (1890) over the Herbert River near Ingham has concrete piers whilst the Lady Lamington Bridge over the Mary River Maryborough (1896) has reinforced concrete abutments, piers and superstructure and is considered 'one of the world's first major concrete girder bridges.'[62] Depree's concrete house was not replicated, until building contractor Walter Taylor used reinforced concrete in a series of high profile projects in the early 20th century including his own house in Graceville (c1912), the Methodist Church, Graceville (1917-1951) and the Indooroopilly Toll Bridge, now known as the Walter Taylor Bridge (1932-1936).[63]

The Depree family resided at 'Goldicott' for only five years before 'anxiety and pressure of work' caused Charles' health to deteriorate.[64] In 1890, he was granted 12 months leave and the family travelled to England where Charles consulted with physicians who recommended rest in a cooler climate. He did not recover and died at Southport on 30 August 1893.[65] 'Goldicott' was let for many years before the Sisters of Mercy, who took up residence and renamed the property 'Mount St Mary's' in 1903, purchased the entire estate at auction in 1902.[66] The statement of significance for its entry on the State Heritage Register reads:

> It is significant as an early and very rare Queensland experiment in concrete housing, and is important in demonstrating a high degree of technical achievement. The concrete construction was innovative and remarkable for its time.[67]

Charles Lambert Depree's experience with concrete in Queensland reruns themes associated with concrete's haphazard development in France and England. His story is pieced together from: a patent which has become detached from its specification drawing and archived under an incorrect name; a drawing of that patented process found amongst Railways Drawings but also listed under an incorrect name; a drawing of buildings, since demolished at Woogaroo Asylum that matches descriptions of the patented process for concrete; and an article in the *Brisbane Courier* which appears to tie these events together and which accords with details and facts in *Minutes of the Institute of Civil Engineers* and *Grace's Guide to Industrial History*. These indicate coincidences and correspondences in actions and terminology that link Depree to notable pioneers in the development of concrete in France.

It is true that success in the colonies was greatly influenced by the time of emigration and the opportunities presented on arrival; Depree's arrival coincided with one of Queensland's frequent recessions and there were limits to the knowledge he brought with him. The colony of Queensland, whose development was hampered by great distances and poor lines of communication, was driven from 1866 by an urgency to establish the rail infrastructure necessary for economic security. Certainly, small innovations in the overall success of the first rail lines to inland centres were lost in the hectic activity by which these achievements were realised. One can only speculate what successes might have attached to Depree, had he arrived 10 years later, armed with a working knowledge of reinforced concrete systems.

Finally, events portray a colony where socially and culturally conservative values stifled modern innovation and development in daily life. Forty writes: "Reactions to concrete are reactions to modernity, and on that account should not be understood as direct affects of concrete, but have to be associated with the whole field of events and processes that constitute modern existence."[68] In 1880s Brisbane, concrete was overlooked in relation to everyday life, confirming a blindness to the onset of modernism.

Endnotes

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[1] Adrian Forty, *Concrete and Culture: a Material History* (London: Reaktion Books, 2012), 16.

[2] Forty, *Concrete and Culture*, 11.

[3] Mr. Abraham Fitzgibbon, engineer, advisor to the Premier and chief proponent of the 3ft 6in gauge: 'Let the country but make the railways and the railroads will make the country' cited in A. E. Cole, "Early History of the Queensland Railways," *Historical Society of Queensland* (27 April 1944): 284 -311.

[4] Donald Watson and Judith McKay, *Queensland Architects of the 19th Century* (Brisbane: Queensland Museum, 1994), 54.

[5] Forty, *Concrete and Culture*, 16.

[6] Andrew Saint, Review of "Le béton: historie d'un matériau by Cyrille Simonnet" in *Construction History* 21 (2005-6): 111.

[7] *Grace's Guide to British Industrial History*. https://www.gracesguide.co.uk/index.php?title=CharlesLambert_Depree&oldid=810865. Accessed 04.09.2017.

[8] Peter Collins, *Concrete: the Vision of a New Architecture: A study of Auguste Perret and his precursors* (London: Faber and Faber 1959), 20. Also Forty, *Concrete and Culture*, 28.

[9] Collins, *Concrete*, 27.

[10] Forty, *Concrete and Culture*, 16 and 17 paraphrasing Cyrille Simmonet, *Le Béton,* 2005.

[11] Collins, *Concrete*, 27. Plans were drawn up by architect, Théodore Lachèz.

[12] Collins, *Concrete*, 27

[13] Collins, *Concrete*, 28. Addendum lodged on 11 December 1855. This second patent recongnised the capacity of concrete to assume any shape and detail and enabled Coignet effective control of building in monolithic concrete in France.

[14] Collins, *Concrete*, 29. Addendum lodged in 24 June 1856. Addendum covered new developments in relation to iron as a tensioning element in concrete. Not yet recognising the role of iron as a reinforcing element. Engineers remained suspicious that iron embedded in concrete would rust.

[15] Leonard F. Beckwith, *Report on Béton–Coignet, its Fabrication and Uses* (Washington: Government Printing Office, 1868). Q.A. Gillmore, "Beton-Coignet: Extract from a report on Beton-

Coignet" in *Beton-Coignet : Description of the Material and its Uses in France and America* (Brooklyn N.Y: N.Y. & L.I. Coignet Stone Co., 1874).
[16] Collins, *Concrete*, 31.
[17] François Coignet cited in Collins, *Concrete*, 31.
[18] Collins, *Concrete*, 39.
[19] Collins, *Concrete*, 39. Miles Lewis, *Two hundred years of concrete in Australia* (North Sydney: Concrete Institute of Australia, 1988). Babbage arrived in Adelaide in 1851 and was appointed Chief Engineer for the Adelaide City to Port Railway in 1853.
[20] Collins, *Concrete*, 39. From this report, Collins is able to conclude that Babbage's house utilised timber formwork and Coignet's recipe for *béton aggloméré.*
[21] B.H. Babbage, Letter, *The Builder* (6 October 1860) cited in Cowen*, From Wattle & Daub to Concrete & Steel*, 82.
[22] Thomas Potter, *Concrete: Its use in building and the construction of concrete walls, floors etc.* (London: E. F. Spon, 1877), 20.
[23] Collins, *Concrete*, 40.
[24] Potter, *Concrete*: *Its use in building*, 85. Collins, *Concrete*, 40. Tall also built a demonstration project, gave lectures at the Architecture Association and published a pamphlet in 1868 which he alleged sold 38000 copies.
[25] Monier's investigations at the time of Depree's stay in Paris were limited to pipes and containers for horticultural use. Hennebique's patent for his building system was not submitted until 1892.
[26] Collins, *Concrete*, 31, 33-34.
[27] *Grace's Guide*
[28] *Grace's Guide*
[29] Particularly "Tall's Apparatus" and "Osborn's Apparatus" illustrated in Potter, Concrete: Its use in building, 86-89.
[30] 'Plans of Queensland Railway Station Buildings, Residences, Bridges and Station Equipment.' The inventor's name is incorrectly recorded in listings as Dupree.
[31] 'Concrete Buildings,' *Brisbane Courier* (8 July 1885): 5.
[32] *Grace's Guide.* Obit in *Minutes of Proceedings of Institute of Civil Engineers* (1842): 390. Downloaded 03/07/2017.
[33] Collins, *Concrete*, 20. Collins notes the use of concrete in England primarily involved the construction of concrete blockwork laid to imitate stone.
[34] *Grace's Guide.* 'Service Reservoirs' were added to Queensland heritage Register 21 October 1992. QHR 600174 Citation notes they are a 'creative and technical achievement of the Colonial era.'
[35] https://environment.ehp.qld.gov.au/heritage-register/detail/?id=600174
[36] Stanley had trained at Edinburgh University and was articled to Messers. B and E Blyth, Consulting engineers to the Caledonian Railways and other railways in Scotland.
[37] *Grace's Guide*
[38] A.E. Cole, 'Early History of the Queensland Railways,' 287.
[39] Cole. 'Early History of the Queensland Railways,' 284.
[40] Cole, 'Early History of the Queensland Railways,' 306.
[41] Grace's Guide; Obit.
[42] Lewis, *Two Hundred Years*, 31. Also Watson and Mackay, *Queensland Architects*, 54.
[43] Watson and Mackay, *Queensland Architects*, 54.
[44] Watson and McKay, *Queensland Architects of the 19th Century*, 54.
[45] Depree's wife was Ella Louise Butterworth. Their children were Charles Fynney, Catherine Edith, Sidney Smallbrook, Jessie Louisa, Ella Maude. A daughter, Catherine Augusta, did not survive. https://www.onegreatfamily.com/fh/Charles_Depree?606852580 Accessed 04/09/2017
[46] Brisbane to Ipswich Rail opened to traffic on 14 June 1875. Cole, 'Early History of the Queensland Railways,' 308.
[47] Other residents included Premiers Sir Arthur Hunter Palmer and Sir Thomas McIlwraith, and Clerk of the Queensland Legislative Assembly, Charles Holmes a Court. Helen Gregory ed. *Arcadian Simplicity: J.B. Fewings Memoirs of Toowong* (Brisbane: Library Board of Queensland, 1990). 'Hon. C. G. Holmes a' Court dead.' *The Queenslander* Sat 26 Jan. 1924: 15. https://trove.nla.gov.au/newspaper/article/25533693
[48] Helen Gregory, *Arcadian Simplicity*, 29.
[49] 'Brisbane's Beautiful Suburbs: Toowong,' *Architecture and Building Journal of Queensland* (7 April 1924): 23-26.
[50] 'Concrete Buildings,' *Brisbane Courier*, 8 July 1885, 5.

[51] 'Concrete Buildings,' *Brisbane Courier*, 8 July 1885, 5.
[52] https://environment.ehp.qld.gov.au/heritage-register/detail/?id=600181 Accessed 12/02/2018.
[53] Rondelet, *Traité de l'Art de Bâtir,* 1802. Cited by Collins, *Concrete*, 20.
[54] John Oxley (1823) cited in *Arcadian Simplicity*, 22. Oxley describes 'low open forest; good grass and iron–bark trees.'
[55] https://environment.ehp.qld.gov.au/heritage-register/detail/?id=600181 Accessed 12/02/2018.
[56] Forty, *Concrete and Culture*, 10.
[57] Cowen, *From Wattle & Daub to Concrete & Steel,* 33.
[58] Watson and McKay, *Queensland Architects of the 19th Century*, 62.
[59] Watson and McKay, *Queensland Architects of the 19th Century*, 169. F.E. Lord, 'Brisbane's Historic Homes,' *The Queenslander.* Date unknown. Included in 'Toowong: Study of a Ridgescape by its residents.' Submission from residents of Toowong to the Australian Heritage Commission, 1995.
[60] Watson and McKay, Queensland Architects of the 19th Century, 172.
[61] Forty, *Concrete and Culture*, 17 cites Collins, *Concrete*, 50; Simmonet, *Le Béton*, 57.
[62] Lewis, *Two Hundred Years*, 10 and 184. Lady Lamington Bridge utilised a system designed by Hungarian Robert Wunsch in 1884.
[63] https://environment.ehp.qld.gov.au/heritage-register/detail/?id=600181 Accessed 12/02/2018.
[64] 'Obituary,' Minutes of the Proceedings of the Institute of Civil Engineers, 391. Accessed 03/09/2017.
[65] 'Obituary,' Minutes of the Proceedings of the Institute of Civil Engineers, 391. Accessed 03/09/2017.
[66] Mount St Mary's Convent entered on Queensland Heritage Register 26/11/1998. QHR601601 https://environment.ehp.qld.gov.au/heritage-register/detail/?id=601601 Accessed 12/02/2018.
[67] https://environment.ehp.qld.gov.au/heritage-register/results/?q=mount+st+mary%27s Accessed 12/02/2018.
[68] Forty, *Concrete and Culture*, 14.