7.07 Knitlock

invention of Knitlock
the Tex-Tile connection
adoption of Knitlock
the diagonal tile

Knitlock was a patent system which was used for only perhaps a couple of dozen buildings, and is one of the least influential aspects of the use of concrete in Australia. But it is one of the most interesting in terms of sources and overseas connections, and this is sufficient justification for discussing it here.

invention of Knitlock

Knitlock was invented by the architect Walter Burley Griffin, and is a far more complete and a far more sophisticated concept than the Mack slab or any Australian system. Johnson surmises that Knitlock arose out of the 'typical workmen's cottage plans' for Canberra upon which Griffin was working in 1914, and that it was actually devised in 1916,[1] but this tells us nothing of his sources of inspiration. It is as wrong to look for literal copying in Griffin's technology as in his design, but it is equally fallacious to suppose that his ideas arose spontaneously and without external influence. Griffin was very much part of his milieu, and the fact that he brilliantly synthesised his sources into his own manner does not mean that they are non-existent.

Knitlock bears some comparison with contemporary Australian systems which also relied upon double concrete skins, such as that of A C Matthews[2] and A H Wardrop,[3] discussed below. The idea of running reinforcing bars through his blocks is something which could easily have been inspired by the American hollow terra cotta construction with which Griffin was familiar. But it is likely to have been triggered more specifically by the work of Anatole de Baudot, given that this was an influence on Griffin at this time in the design of Newman College. De Baudot's well-known church of St-Jean-de-Montmartre had major elements of concrete, but the balance was of hollow tiles with reinforcing bars running through them.[4]

Griffin had attempted to develop a dry system of masonry construction, but was forced to compromise upon hand grouting of the vertical joints. Knitlock was patented in 1917,[5] and it was stated in the specification

1 Information from Donald Johnson, 1998.
2 *Australian Home Builder*, no 1 (August 1922), p 75.
3 *Australian Home Builder*, no 5 (August 1923), p 46.
4 F S Onderdonk, *The Ferro-Concrete Style* (New York 1928), p 42.
5 Walter Burley Griffin, applicant, and David Charles Jenkins, assignee, patent application no 4171/17, 31 May 1917.

> Our integrated construction is ordinarily hollow or has cavities and is formed of two opposed (namely outer and inner) courses of segments which are vertebrated and continuously articulated as hereinafter described and have lapped edge joints. with this object we provide on one face of each segment certain parallel recesses which are alongside of and are partly enclosed by parallel ribs. There is an outer and an inner course of these segments, with in one form of our construction their ribbed and recessed faces interlocking, and with edges of outer segments located opposite solid portions of inner segments, so that the integrated construction displays imbrication. The segments will be further bound together or be insulated in some cases by metal reinforcement, or grouting, cement., concrete, bitumen, heat resisting material, or by putting between the segments any impregnated paper or fabric in use for insulation.

A company, with its headquarters at Griffin's Melbourne office, was formed to exploit it.[6] As Griffin himself described the principle:[7]

> 'Knitlock or 'Segmental Architecture' is a system based on engineering principles for economy of design, steel rods being introduced whenever tensile stresses may occur. It is based on machines for cheap manufacture, and lightness and compactness for minimizing transport, and on standard units assembled without hand fitting, cutting, bedding or plastering for speedy erection.
>
> It is founded on the rhythmic law for architectural effectiveness, and is adapted to every requirement of shape and size for utility.

Of the technical details, Griffin said:[8]

> Technically there are only two types of segments - vertebral, which lock together to make the frame work or skeleton, and tesseral, which lock together for two-ply curtain walls, attaching to and stretching between the vertebral columns.
>
> The double wall provides for lap joints everywhere, and between the inner and outer layers there is an insulation layer of bitumen, as well as a proportion of air ducts in the interlocking keys ... In these flutes also are concealed gas and electric conductors.
>
> In erection, the segments are simply slipped together from above, the vertical joints being filled by pouring in concrete grout, in special cases with steel reinforcing rods. With the manufactured half segments all the openings and corners work out accurately so that, without cutting or fitting, the grooved frames of the doorways and windows and fixtures are likewise slid into place and made fast with grouting also.

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6 D L Johnson, *The Architecture of Walter Burley Griffin* (South Melbourne 1977), p 56.

7 [W B Griffin], 'Knitlock Construction', *Australian Home Builder*, August 1922, p 73, quoted Johnson, op cit, pp 57-8.

8 W B Griffin, 'Segmental Architecture', *Australian Home Beautiful*, V, 9 (1 September 1927), p 14.

> Externally the segments appear mainly as twelve inch chequers with tuck-pointed joints, the effect at Castlecrag being cut stone, the colours being supplied by the sands selected for the surface - white, purple, pink, yellow and yellowish green.

the Tex-Tile connection

Despite the substantial involvement in terra cotta hollow tile construction of members of Frank Lloyd Wright's circle, it cannot be claimed that the master himself was affected. No projects by Wright using this system have been reported, and it is notable that his 'A Fireproof House for $5000' project in the *Ladies Home Journal* in 1906[9] was intended to be built in concrete (or at least, so it is always reported, though I would wish to see it confirmed). When actually executed in two versions as the Stephen Hunt house I at La Grange, Illinois, in 1907, and as the G C Stockman house in Mason City, Iowa, in 1908, it was in each case of timber covered with expanded metal, and what Brooks refers to as 'plaster'.[10] The idea of Textile Block must in broad terms have been influenced by the great proliferation of building systems in concrete as well as in terra cotta at this time, but the specific resemblance to one of the more obscure terra cotta systems could, in fairness, by fortuitous. On the other hand the name of his construction must, at a conscious or an unconscious level, have derived from the Natco Tex-Tile. Though Wright might have been spurred by some sense of rivalry with his former pupil, the idea that he in any meaningful sense derived his system from Griffin's is improbable, not least because of the fundamental differences between the two.

Griffin himself did a certain amount to suggest a connection. He referred to Wright's Textile block system in promoting his own Knitlock, and actually illustrated the Freeman house in his article 'Segmental Architecture'. 'In Southern California,' he said[11]

> Mr Frank Lloyd Wright has recently carried out segmental houses on a scheme having tesseral elements of the same facial size and similar appearance, though quite different in structural significance, since they form cavity walls in the ordinary sense, stable because of their mass rather than through specialised columnar or concentrated supports, and there are no vertical segments. As illustrating the expression of segmental architecture through an independent mind, his Hollywood and Pasadena projects are of much interest.

Despite the distinction which Griffin drew between the systems, there were similarities which went beyond the size and appearance of the blocks. In both systems the blocks were formed so that steel strands or rods could be placed in the joints and liquid concrete poured in to *knit* them together (as Wright put it).[12] It was Marion Griffin who claimed that

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9 Illustrated in G C Manson, *Frank Lloyd Wright to 1910* (New York 1958), p 182.

10 W A Storrer, *The Architecture of Frank Lloyd Wright* (2nd ed, Cambridge [Massachusetts] 1982 [1974]). pp 138, 139; ******** Brooks, *The Prairie School,* pp 123-4.

11 W B Griffin, 'Segmental Architecture', *Australian Home Beautiful,* V, 9 (1 September 1927), pp 13, 63.

12 Johnson, *Architecture of Griffin,* p 56.

Wright's 'textile block' was based upon Knitlock, and that the editor of *Building*, George Taylor, or an 'envoy' of Taylor, had visited the United States and had told Wright about Knitlock.[13] Johnson cites a letter by Griffin himself which refers to this 'envoy' visiting the United States in 1919.[14] It would be interesting to see the text of this, for these solemn assertions about envoys do not ring true. Taylor does seem to have been hostile to Griffin, but he was not in a position to be despatching envoys around the world, and nor would he have had any purpose in doing so. The reference may be to some Australian traveller, or to the unnamed 'Master Builder' who accompanied Taylor to the United States, and who, unlike Taylor, had met Wright.[15] It may even be to an American resident who had undertaken some errand or message for Taylor.

It is interesting that Griffin's reference to this envoy is made in a letter to the architect W G Purcell, for Taylor himself spent a day with Purcell, at his house on Lake Place, Minneapolis. Taylor was much impressed, and in his published account of the trip reproduces no less than five photographs of Purcell's very Sullivanesque architecture.[16] Purcell had worked for Sullivan for five months in 1903,[17] and at a later time, along with Wright, Griffin and Elmslie, had designed houses for Griffin's Rock Crest Rock Glen subdivision in Mason City, Iowa. He was if anything somewhat hostile towards Wright, and a supporter of Griffin, upon whom he wrote an article which was published in *Western Architect* in 1912.[18]

No new insights can be offered here into the development of Textile Block itself, but the main features should be reviewed. Wright claimed to have begun thinking about the system after his return from Japan in 1917, which would make it just possible in theory for it to have preceded Griffin's Knitlock. But there is no real evidence that he had got anywhere with it at this stage, and his first houses on this system are the Millard house, Pasadena; the Freeman house, Hollywood; and the Storer and Ennis houses in Los Angeles, all built in 1922-3, and all related to the Hollyhock House in design. The system was purportedly invented by Wright and his son Lloyd, and consisted of concrete blocks of various patterns and sizes, linked with vertical and horizontal steel rods. The Freeman house, though quite small, required over eleven thousand blocks. More than forty different patterns were ultimately required, and the blocks proved to be difficult to mould, fragile and highly water absorptive.[19] It is surprising that they should have proved so problematic, for even where the face is cast in ornamental relief the blocks are fairly simple, and certainly far less difficult to cast than Griffin's Knitlock components. The typical block is square on the surface, but Wright chose to illustrate a version twice as long as it was high. All four edges are grooved to receive the steel rods and grout, and the rear or inside face is recessed so that each block is hollow backed or like a shallow box.[20]

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13 Marion Griffin, 'The Magic of America' [Burnham Library typescript], section IV, pp 407-8, quoted by Johnson, *Architecture of Griffin*, p 58.
14 Griffin to W G Purcell, July 1919, quoted by Johnson, *Architecture of Griffin*, p 58.
15 George Taylor, *"There!" A Pilgrimage of Pleasure* (Sydney 1916), p 190.
16 Taylor, *"There!"*, pp 339-343.
17 Brooks, *The Prairie School*, p 131.
18 Brooks, *The Prairie School*, p 198.
19 Secrest, *Frank Lloyd Wright*, pp 289-291.
20 Illustration from *The Natural House* (New York 1954), reproduced in Edgar Kaufmann, 'Frank Lloyd Wright: Plasticity, Continuity, and Ornament', *Journal of the Society of Architectural Historians*, XXXVII, 1 (March 1978), p 36.

The son, Lloyd, constructed eleven Textile block houses on his own, and then in February 1928 the architect A C McArthur, a former pupil, approached Wright for permission to use the system for his Arizona Biltmore Hotel project. Wright licensed the system to McArthur, and was paid a retainer during the construction period, but there is much evidence to suggest that Wright actually designed the building and allowed it to go under McArthur's name. The hotel was opened in November 1929,[21] and in 1930 McArthur received a letter from lawyers acting for William E Nelson, the holder of two patents relating to concrete block construction, claiming that Wright's system violated these. Wright conceded that for technical reasons he had been unable to patent the system,[22] and we may well surmise that this was on account of its similarity to the various hollow block systems, quite apart from any invention by Nelson.

Thus the basic Knitlock walling system is both novel and ingenious, but this is not to say that it was entirely without precedent: that precedent lies in various usages of the Natco hollow tile, a product with which Griffin was undoubtedly familiar. Griffin and other members of the Prairie School were significantly involved in hollow tile construction, though Frank Lloyd Wright probably was not. There is no reason to suppose that Wright's Textile Block was copied from Griffin's Knitlock, but it bears some relationship to the same ultimate source, the Natco tile. If there were any doubt about this, the fact that the name 'textile' was copied as well, must dispel it.

adoption of Knitlock

Griffin met the usual resistance from the authorities, and their doubts seem to have been reasonable enough. In 1918 the council of the Melbourne suburb of Malvern gave him approval to put up a demonstration house - which if built would have been our earliest known example - but this did not proceed because Griffin couldn't obtain a suitable site. Subsequently a Knitlock structure was put up elsewhere in the suburb, and apparently was regarded by the council as unsatisfactory. On 15 October 1920 Griffin wrote to the town clerk to remonstrate against the council's failure to approve another proposed house in Kooyong Road, arguing that the proposed building would have 'bone dry ventilated walls and an intrigal [*sic*] finish', and would be more substantial than the usual brick building. The council approved the proposal on the condition that Griffin himself supervised it, but it did not proceed. Although he had previously said the house was intended as his own, he advised the council in March 1922 that he was selling the property and the purchaser was having new plans prepared (implicitly by Griffin himself, as he refers to 'my client'). This became the W R Paling house.

Griffin had told the council that the earlier and unsatisfactory building in Malvern was 'an entirely different class of building and under entirely different auspices, with the plans and specifications of which I had nothing whatever to do.' This suggests the D C Jenkins house

21 ******* Secrest, *Frank Lloyd Wright,* pp 350-353.
22 Secrest, *Frank Lloyd Wright,* p 354.

at 139 Manning Road, which would be consistent with the fact that Jenkins was a builder himself, and was Griffin's partner in the Knitlock patent. However a number of others had already experimented with the construction, and Griffin named some of the architects who had 'investigated' the system as C A D'Ebro (now dead), North & Williams, Klingender & Alsop, Eggleston & Oakley, and Sutherland & Sutherland.[23] We know that Klingender & Alsop built the house 'Jura' at Lorne of Knitlock in 1919, and it seems likely that early examples by the other architects are yet to be identified

It cannot be said that Knitlock fulfilled its early promise, for other architects did not pursue it further, and its users were limited to Griffin and his immediate associates.[24] He was nevertheless still promoting it in 1930 as a cheap form of construction for general use. 'Economy', according to Griffin,[25] was

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23 W B Griffin to the Malvem Town Clerk, 15 October 1920; Town Clerk to Griffin, 28 October 1920; Griffin to Town Clerk, 11 March 1922: Stonnington City Archive, courtesy Di Foster.

24 Some examples of Knitlock structures are:

'Jura', Campbell house, 240-242 Mountjoy Parade, Lorne, by Klingender & Alsop, 1919. Personal observation by MBL & subsequent research by Megan McDougall, Historic Buildings Council.

D C Jenkins house, 139 Manning Road, Malvern. D L Johnson, *Australian Architecture 1901-1951* (Sydney 1980), p 131.

'Pholiota', 23 Glenard Drive, Heidelberg, the Griffins' own house, by Griffin, 1919 (most authorities) or 1920 (Harrison) [with substantial additions].

Vaughan G Griffin house, 52 Darebin Street, Heidelberg, by Griffin, probably 1921-4 (now with a terra cotta tile roof).

'Gumnuts', originally small twin cottages, 619 Nepean Highway, Frankston, by Griffin, c 1922.

'Stokesay', 288-9 Nepean Highway, Seaford, for Arthur P Onians, by J F W Ballantyne, 1922. Miles Lewis, 'Stokesay [mimeograph report, Melbourne 1989].

116 Knight St, Shepparton, built by John Sandy (later of the Knitlock Syndicate Co), 1922 (Turnbull).

Farmhouse extension at Arcadia, near Shepparton, built by McDermott, uncle of John Sandy, ?c 1922 (Turnbull).

Grandstand, Winchelsea, 1922-3. Information from David Wixted, 1993, and Lorraine Huddle, 1997 [see below].

S R Salter house, 16 Glyndebourne Avenue, Toorak, by Griffin, 1922-4, or 1924 (Harrison).

W R Paling house, 248 Kooyong Road, Toorak, by Griffin, 1923, or 1924 (Harrison) [demolished].

T Felstead [later Redding] house, 158 Edinburgh Road, Castlecrag, Sydney, by Griffin, 1923-4.

Julian S Jefferies house, 7 Warwick Avenue, Surrey Hills, by Griffin, completed 1924.

E E V Mower house, lot 158, The Rampart, Castlecrag, Sydney, by Griffin, 1924.

A E Creswick house, 4 The Barbette, Castlecrag, Sydney, by Griffin, 1926.

A F Duncan house, 8 The Barbette, Castlecrag, Sydney, by Griffin, 1933 [Knitlock and stone].

Foster house, Brighton, by Griffin [?not surviving].

Real estate office, Nepean Highway, Edithvale, by Griffin [demolished early 1960s].

A H Wills house, Dickens Street, Woodend, apparently by Griffin, no date

A T Carthew house, Seaford, by Ballantyne, 220 Nepean Highway, Seaford, no date. Melbourne University Architectural Collection.

Hayward house, 6 Third Street, Black Rock.

Oatlands Country Golf Clubhouse, Telopea, New South Wales, by Pitt & Morrow.

This list derives from James Birrell, *Walter Burley Griffin* (St Lucia [Queensland] 1964), passim, Johnson, *Architecture of Griffin*, information from Peter Navaretti, Jeff Turnbull, and other sources as indicated, including Peter Harrison, *Walter Burley Griffin Landscape Architect* (Canberra 1995). David Wixted first advised me of the grandstand at Winchelsea, but Lorraine Huddle has since provided detailed information to the effect that it constructed in 1922-3 by the local builder W T Warner.

25 W B Griffin, 'Concrete Construction Conforms to Landscape in Castlecrag Subdivision, Middle Harbour (N.S.W.)', *Highways*, III (August 1930), pp 30-1, quoted Johnson, op cit, p 58.

aimed for in the reduction of the fielded work eliminating cut and try processes; and to this end the doorways and windows and fittings constitute special standardised "segments" of themselves, completely prepared and coated in the shop and inserted without adapting or waiting for measurement in the erection operations. All the essential parts of these fixtures are thus made standard and carried in stock.

the diagonal tile

The concrete roof tile which was devised for the system was patented in the following year,[26] had a twelve inch (300 mm) exposed face and was laid on the diagonal. This was reminiscent of a number of earlier roofing systems of similar appearance, and especially of the asbestos cement roof tiles which were common in Australia in Griffin's time, but it may have been directly copied from an American concrete tile which is identical in form and dimension. The American tile in turn relates to very similar German concrete tiles, and to the French 'Courtois' tile of the mid-nineteenth century, already discussed. The first of the German tiles were apparently developed in 1844 by Adolph Kroher, who experimented with various shapes but selected one which was the same in principle as the later square tiles though it was slightly diamond-shaped rather than square, and with only shallow projections, the form of which is not entirely clear.[27]

Hartwig Hüser of Oberkassel took out his own patent for a diamond-shaped tile in 1878,[28] and subsequently G Rademacher of Holstein made an improved version, under a patent of 1898, in which the joint had a double key.[29] Of all of these, however, a pattern from Westerndorf, near Rosenheim, most closely approaches the Knitlock type, with very simple projecting flanges at the edges.[30] Many tiles from the 1890s onward appear to be of a square rather than a diamond pattern, but documentary evidence of this is lacking. Meanwhile diamond pattern tiles made on German machines appeared in England in about 1895,[31] and many of these developments were influential in Denmark (certainly in Schleswig Holstein). The American version was 'invented' in about 1904 by C C Christensen, whose name is suggestive of Danish extraction, president of the Perth Amboy Stone & Roofing Tile Company of Perth Amboy, New Jersey. Christensen's tile was also of cement, square in shape, twelve inches in size, laid diagonally, and fitted with upward ridges on two adjoining edges, and downward ones on the other two.[32]

We may conclude from all of this that Griffin's concrete roof tiling was not novel in any significant way. His wall construction on the other hand, is a significant innovation. But was

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26 Walter Burley Griffin, applicant, and David Charles Jenkins, assignee, patent application no 6690/18, 2 March 1918.
27 Charles Dobson, *The History of the Concrete Roofing Tile* (London 1959), pp 9--13.
28 Dobson, *Concrete Roofing Tile*, p 46.
29 Dobson, *Concrete Roofing Tile*, pp 42-4.
30 Dobson, *Concrete Roofing Tile*, p 66.
31 Dobson, *Concrete Roofing Tile*, p 52.
32 *Concrete*, I, 4 (June 1904), p 23.

it Griffin's invention, was it copied from Frank Lloyd Wright’s Textile Block, or was Wright's block copied from Griffin’s system?