10.09 Cyclone Design

a. cyclones and storm battens
b. the Knuckey Street church
c. hook bolts & ties
d. Queensland practice
e. post-Tracey

a. cyclones and storm battens

The history of cyclone design in Australia has been, so far as I am aware, a very scanty one until quite recent years. But an enormous area in the coastal regions of the north is subject to cyclones, and hurricanes and windstorms occur less predictably elsewhere. In 1893 Nellie Hoche wrote from Farina, south of Marree:[1]

> On Sunday we had the biggest hurricane I ever saw; nearly all the aunties [external privies] done the 'disappearin' trick', to say nothing of verandahs etc. I saw our auntie make her bow and depart real graceful, then our next door neighbour's and we began to think the house would be next, but she is a good sticker, thank goodness.

It has been claimed that the iron pillars of the Quaker Meeting House in North Adelaide 'tied down' the verandahs, and represent 'a remarkable perception of climate control' by the maker, Henry Manning,[2] but there is no evidence that this was the intention, and nor would there have been any need for such a precaution in Adelaide. The first reference to any conscious precautions is in 1872, when the town of Cossack was established on the north coast of Western Australia, an area ravaged in previous years by what were known as 'willy willies'[3] or 'cock-eyed-bobs'.[4] The buildings are reported to have been anchored with steel cables, and some with anchor chains which passed over the roof and were bolted to boulders in the ground,[5] or else to concrete blocks, as was reportedly the norm up to 1888.[6] In 1905 Robert Haddon spoke of the system, used in parts of Westen Australia, of anchoring roofs by throwing cables over them and pinning them down.[7]

In the same general area roofs seem regularly to have had strips or 'storm battens'[8] on the surface running transverse to the slope, and presumably bolted through to the

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1 Helen Ferber, *Stagecoach to Birdsville* (Kenthurst [New South Wales] 1995), p 22.
2 Peter Bell, *Timber and Iron* (St Lucia [Queensland] 1984), p 108.
3 N E W Taylor, *A Saga of the North-West: Yeera-Muk-A-Doo* (Fremantle [Western Australia] 1987 [1980]), p 170.
4 Ray & John Oldham, *George Temple-Poole* (Nedlands [WA] 1980), p 16.
5 Taylor, *Saga of the North-West*, p 170.
6 Oldham, *George Temple-Poole*, p 16.
7 R J Haddon, 'Building Construction Text Books', *Journal of the Royal Victorian Institute of Architects*, July 1905, p 87.
8 Oldham, *George Temple-Poole*, p 12.

underside to prevent the sheets being peeled off. Thus the two major techniques for resisting cyclones had both appeared, but the origins of neither are known.[9] When storm battens began to be used is unclear, but they are widespread in photographs from at least 1887, and many may yet be seen today.[10] The system may have derived from the frame of jockeys and riders placed over a bark roof. Peter Bell illustrates at cottage at Ravenswood with an iron roof but with a complete over-frame of this sort, and states that there still survived at Ravenswood, at the time of writing, four iron cottages each with some sort of wood or pipe weighting on the roof. It would be logical that such a frame should be bolted down through the roof sheeting and, if so, that the raking members could then be omitted as superfluous. In reality, however, the evidence tends to suggest that storm battens precede complete over-frames rather than the reverse.[11]

b. the Knuckey Street church

The most interesting example of anti-cyclone design is the former Wesleyan Church at 57 Knuckey Street, Darwin.[12] What follows is extracted from my report on the building of 1989, and I must acknowledge the contribution to this of Duncan Marshall, especially in locating and copying a photograph of the building taken before it was despatched from Adelaide. The earlier Wesleyan chapel on the site had been built in 1873, but destroyed in the cyclone of February 1897, and it was in April or May that advice was received from Adelaide that a new church was being prefabricated there. The structure was constructed by A Simpson & Son of Adelaide, who were normally metalware manufacturers rather than builders, and it was assembled at their premises in Wakefield Street. It is a steel framed building using some very specialised components, such as vertical members made up of flat bars over which clip sheet metal sections so as to create a cruciform section: to fix the cladding is fixed to this cruciform member a further sheet metal cover strip is clipped on. The cladding itself is of pressed steel imitating the profile of weatherboard, a form which has not so far been reported in Australia, but which is known to have been made in America.[13] It seems likely that all the components were imported from overseas rather than manufactured by Simpsons.

The specifically cyclone resistant elements were four ties holding down the corners, which appear in the Adelaide photograph to be cables: what survive on site are the remains of chains which were anchored into concrete at the ground level. More debatable is the use of hook bolts to anchor the roof sheeting to the steel purlins, for it is not even certain that this was the original system, as the roof sheeting has been replaced. If it was the original system, it might have been **chosen** with cyclone resistance in mind, but it was not originally **devised** for that purpose.

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9 Taylor, *Saga of the North-West,* pp 111, 129, 131, 181, 223.

10 Oldham, *George Temple-Poole,* pp 12-13.

11 Bell, *Timber and Iron,* p 108.

12 Miles Lewis, 'Former Wesleyan Church, 57 Knuckey Street, Darwin: Assessment of Objections [mimeographed report, May 1989].

13 This cladding appears in a trade pamphlet which I have obtained only since the date of my original report: *Porter Iron Roofing and Corrugating Co* (Cincinatti [Ohio], no date [?c1885-90]).

c. hook bolts & ties

As evidence that this was the sort of fixing one might choose for cyclone resistance (if common sense is not enough to support the contention) I would cite a somewhat analogous fixing system in a homestead which has been moved into the grounds of the 'Tin Pannikin' at Herberton in northern Queensland. Here the roof sheeting is anchored down to a timber edge beam by means of large nails, the pointed ends of which pass **upwards** through the top of each corrugation, and have been threaded to take nuts. The heads hang down beside the beam and are fixed to it by staples driven sideways. This would appear to be a deliberate cyclone measure, comparable with the use of the hook bolt.

The hook bolts, however, were not originally conceived for cyclone resistant design, for something of the sort was used even in Europe by the 1860s for fixing Vieille Montagne zinc roofing.[14] In the 1890s 'galvanized roofing hooks' were advertised by Farmiloes of London,[15] and by the early twentieth century a version was sold in Britain as Thomas's patent fittings. These would be a natural enough choice for fixing roof sheeting to steel purlins, as drilling the purlins would be unrealistic, and wire ties rather unsatisfactory. The fittings as advertised[16] had each bolt provided with a metal saddle and washer, and the intention was to raise the roof sheeting slightly off the purlins, so as to avoid condensation dripping off, and to seal the point where the bolt passed through the roof sheeting. Hook bolts (without the saddles and washers) became the standard method of attaching roofing to steel purlins.[17] In 1924 Dorman Long & Co sold them in six sizes, between four and five inches [100-125 mm] long, and in $^{5}/_{16}$ or $^{3}/_{8}$ inch [[8.0 and 5.5 mm] diameter.[18]

These clips can be found in Australia in one structure which dates from 1889. This is a hospital, one of the first steel framed buildings in Australia, said to have been manufactured at Teesside, England, and put up at Burrundie in the Northern Territory. However it was relocated in 1913 to serve as the mining warden's quarters, post office and repeater station at Pine Creek, where it still stands today.[19] We cannot be certain whether the present fixings are original or date from 1913 or, in the latter event, whether the original system was the same. An even more interesting structure is the former Methodist church at Darwin, built to replace an earlier building destroyed by cyclone in 1897. The church was built and possibly designed[20] by A Simpson & Son

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14 R S Burn, *Modern Building and Architecture* (London, no date [c 1870]), p 198; R S Burn, *The New Guide to Carpentry, General Framing and Joinery* (Glasgow, no date [c 1870]), p 350 & figs 439, 440.

15 T & W Farmiloe, *T. & W. Farmiloe's Miniature Catalogue* (London 1894), p 928.

16 J E Sears, *The Architect's Compendium and Catalogue* [London 1907], p 289.

17 *Roof Plumbing* [Australia, Department of Labour and National Service, technical bulletin no 103] (Melbourne 1946), pp 17, 76.

18 Dorman, Long & Co Ltd, *Handbook for Constructional Engineers containing tables relating to Steel, &c* (Middlesborough [Yorkshire] 1924), p 225, and illustration of their use, p 188.

19 Carol Hardwick, Register of Significant European Cultural Sites in the Northern Territory (2 vols, Darwin 1984), II, pp 482-3.

20 The Rev Arch Grant has advised me, 1995, that he has interviewed Mr Moxom Simpson, who is positive that his grandfather designed the building.

of Adelaide,[21] and was assembled on their premises in Wakefield Street[22] before being despatched. The roofing is fixed by hook bolts onto the metal framing members, but once again the present roofing is a replacement and we cannot be sure that the original was fixed in the same way.

I know of no contemporary discussion of cyclone measures in which either corner ties or hook bolts are advocated. In fact the only contemporary consideration of cyclone design of which I am aware is that of Robert Haddon, writing of what seems to be the same method as that used earlier in Western Australia:

> In Hurricane Zones. - In districts subject to hurricanes or excessively high winds roof iron should be further secured with long tough wooden battens laid along horizontal joints outside and bolted right through the roof timbers to the inside. This is to prevent individual sheets being torn off.[23]

Not long after this the influential editor of *Building*, G A Taylor, noted whilst travelling that 'Most of the Fijian buildings are tied down with steel ropes' to resist hurricanes[24] - that is, a solution resembling that of the Darwin church - but he does not seem to have promoted the idea for use in Australia.

d. Queensland practice

Some of the design principles adopted in Queensland were not so immediately recognisable as anti-cyclone measures. One was to carry the studs of the frame down past the floor joists, which is simply a reversion to the balloon frame principle rather than that of the platform frame. Another, especially common in churches, was to continue the floor bearers laterally beyond the external walls, then to tie the walls to their outer ends with raking timbers. These ties were sometimes clad in the same weatherboard as the building, causing them to evoke a masonry buttress.[25] Peter Bell reports the use of more elaborate measures at the Cardwell Telegraph Office, apparently installed at some indeterminate date subsequent to its construction in 1870. The walls of the core building have twelve 12 mm cyclone bolts linking the top and bottom plates, and four 20 mm steel tie rods with threaded tensioning nuts connect the top plates horizontally across the building.[26] In 1912 school shelter sheds in Queensland, which regularly had a 1.2 m roof overhang, were required to have the

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21 Photograph by McGann, 'Portable Iron Church for the Palmerston Wesleyan Congregation built by A Simpson & Son - Adelaide 1897', in the possession of the Rev Stafford, cited by Duncan Marshall, AHC file note (a), 10 January 1989.

22 Stafford believed the building to have been assembled in Pirie Street, however this is contradicted by the company's centenary history, *Today not Tomorrow, a Century of Progress*, Adelaide 1954, p 28, cited by Duncan Marshall, AHC file note (a), 10 January 1989. This states that the building was erected on a vacant lot in Wakefield Street, and elsewhere it makes reference to the existence a factory owned by the firm in Wakefield Street in the 1890s (pp 24-5) and to a two acres site there in 1894 (p 33). Marshall has observed that the factory buildings and fire tower in the background of the photograph suggest Wakefield Street as the location.

23 Robert Haddon, *Australian Architecture* (Melbourne, no date [1908]), p 415.

24 G A Taylor, *"There!" A Pilgrimage of Pleasure* (Sydney 1916), p 32.

25 Information from Richard Allom, 1991.

26 Bell, *Timber and Iron*, pp 199-200.

outer end of the iron sheeting secured with half inch [13 mm] bolts passing right through the batten and the rafter, doubtless to resist cyclone uplift.[27]

It also became common in cyclone-prone areas to bolt the joists to the bearers, or better still to strap the plates right through to the stumps. The specification for a rural school at Boonah in 1919 prescribed:

> ANCHOR STRAPS: - At all angles fix one and a half (1½) inch by half (½) inch [38 x 13 mm] wrot iron anchor straps, secured to stumps with two (2) three (3) ins. [76 mm] coach screws and to plates with No. two (2) half (½) inch [13 mm] diam. wrot iron bolts. Anchor straps to be kept clear of stump caps.[28]

This technique was being used by J R Saville in 1935[29] and, as will appear, was still recommended by C R Virgoe in 1955.

In 1929 the *Architectural and Building Journal of Queensland* quoted a report from Townsville on the use of pisé construction which, it was held, would

> resist cyclonic storms admirably. The roof would require some special attention on account of the overhang, which is primarily intended to protect the walls against wet weather. Cyclonic storms may get under the eaves, but if the projecting ceiling joists are carefully anchored down by ironbark posts ... no harm would be likely to arise. Low or flat roofs are a good protection against cyclones.[30]

The roof might be secured also by internal angled braces, as is exemplified in the drawings for two drill halls (undated). In one case, at Allora, the roof is carried on timber and iron king post trusses, and 45° braces run from each column to the bottom chord. At Townsville the trusses are of steel angle, and the braces run not merely to the bottom chord, but past it to the top one.[31]

The next overt anti-cyclone measures in Australia were also concerned with securing the eaves. They are the angled stays used in huts built by the Sidney Williams company in the 1940s, which are apparently seen as tying the eaves back to the vertical wall. Sidney Williams had been prefabricating buildings in Rockhampton in the 1890s, later opened a Sydney branch, and built the Qantas aircraft hangar at Parap, Darwin, in 1939.[32] Williams himself died in 1936, but from the 1940s his

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27 Drawing 'Playshed at State School, Redbank Plains', contract 4 December 1911 [a standard drawing, completed for this contract], held by the Historic Places Branch, Brisbane; also information from Stephen Murray, 1991.

28 'Specification: Erection and Completion of a new Rural School: Boonah', 17 February 1919 (held by Historic Buildings Branch, Brisbane), p 6.

29 J R Saville [of Townsville], 'Proposed Store for G K Fraser Esq, Trebonne' [drawing], 20 November 1935, Queensland University of Technology, School of Architecture, Interior and Industrial Design Archives.

30 *Architectural and Building Journal of Queensland*, VIII, 87 (10 September 1929), p 32.

31 Incompletely identified drawings of Allora and Townsville drill halls, Queensland University of Technology, School of Architecture, Interior and Industrial Design Archives.

32 Carol Hardwick, *Register of Significant European Cultural Sites in the Northern Territory* (2 vols [Darwin] 1984], I, p 268.

company supplied the standard huts, which use these stays, as part of the World War II construction program.[33]

In 1955 the Queensland architect C J Virgo, in his *Australasian Building Knowledge*, devoted a small section to 'Special Fixing in Cyclone Areas', which consisted of[34]

(a) Additional bracing to wall framing, and bracing to stumps at all angles. Anchor straps to each alternate stump.

(b) The insertion of dragon ties at angles of building, both at top and bottom of walls. These should be checked and bolted to the plates.

(c) Veranda top plates to be bolted and rafters to be fixed to veranda posts by strap bolts, and intermediate rafters bolted to top plate.

(d) Alternate studs to be secured to top and bottom plates by strap bolts.

(e) Veranda posts halved and bolted to bottom plates.

(f) Corner and angle studs to be fixed with angle iron bolted to side of studs and onto top surface of bottom plate.

Where possible lining boards should be taken through and double nailed to bottom plates.

In 1 958 a cyclone in the Bowen area destroyed seventy-seven houses, and a technical officer of the Qyueensland Housing Commission iurged that al houses inthe area should take the precautions followed by the Commissioin itself (which were similar to Virgoe's):

closed gable ends

braced stumps

anchor bolts 10 ft [34 m] long from the stumps to a roof member

regulalar tightening of roof sheeting

e. post-Tracey

Cyclone Tracey devastated Darwin on Christmas Day 1974, and in its aftermath there were increased efforts to design cyclone-proof buildings. The Darwin Reconstruction Commission determined upon what Welke and Harris call 'gun-turret-type tactics',

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33 Hardwick, *Sites in the Northern Territory*, cites 28 Westralia Street, Stuart Park, Darwin, of 1943-4 (I, pp 83 ff); St Paul's Church of England, 6 Victoria Highway, Katherine, of 1945 (II, pp 586 ff); and 27 First Street, Katherine, undated (II, pp 562 ff).

34 C J Virgo, *Australasian Building Knowledge*, vol II (Brisbane 1955), p 73.

and favoured houses without stumps, and with much reduced fenestration and cross-ventilation.[35] Lawrence Howroyd of Howroyd Safety Housing Pty Ltd, an associate of BHP, patented the Howroyd Safety House, constructed of steel and glass, with verandahs which hinged down to become shutters, and a ridge vent which doubled as a skylight to the central bathroom and service core.[36]

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35 Adrian Welke & Philip Harris, *Darwin: a Map Guide to the Architectural Heritage of the City* [Royal Australian Institute of Architects, Northern Territory Chapter] (Darwin, no date), p 30, citing houses off McMillan's Road, Anuda.

36 Welke & Harris, *Darwin: a Map Guide,* p 28.