Cape Adare's historic huts

A comparison of the construction methods

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Cape Adare huts with penguins, Photo G.Turner

Introduction

Three huts were constructed at Ridley Beach, Cape Adare during what has become known as the *Heroic Age* of Antarctic exploration (1895 to 1917). These are Borchgrevink's living and stores huts; 2) Scott's Northern Party Hut, which is known as Campbell's Hut.

The two huts used by Carsten Borchgrevink's *Southern Cross Expedition* (1899-1900) party to accomplish the first Antarctic land "winter over", although deteriorating, are still intact whereas Campbell's hut, that formed part of Scott's *1911 British Antarctic Expedition,* has disintegrated. The development of a constructional premise to explain the disintegration of Scott's Northern Party Hut is the subject of this article.

Location, Topography and Climate:

Cape Adare separates Robertson Bay from the Ross Sea. Ridley Beach is located at the head of the cape at $71^0$18'S, $170^0$09'E. It consists of a 73 hectare, triangular shaped gravel beach with ridges of gravel and lagoons of stagnant water[i]. The beach rises gradually from sea level until it butts into the steep volcanic cliffs that rise up to 350m. According to David Harrowfield *"These cliffs have an important influence on local weather, particularly during east-southeast storms, which in autumn, winter, and spring reach speeds exceeding force 11 on the Beaufort scale."* [ii]. Harrowfield describes the winds as katabatic type (action of gravity on cold-air drainage down a slope) with the speeds exceeding 145 km h^{-1}. [iii] It is these winds that are responsible for most of the deterioration occurring to Borchgrevink's huts and for the destruction of Campbell's historic hut. Light rain can occur occasionally in summer and temperatures of 12^0C have been recorded with 90% relative humidity in mid January (D.Harrowfield pre. comm 1998).

Borchgrevink's Huts 1899-1900

The two beautifully detailed huts that Borchgrevink built had been prefabricated in Norway and were constructed of Baltic Pine planks (Picea abies), 40 to 50 years old[iv], well seasoned and selected. Each plank was cut from either side of the heart of the tree providing only two boards per log (R. Skerten per. comm. 1998) with finished sizes of 145mm wide and 60mm to 70mm thick[v]. They were half notched at the corners in traditional Norwegian plank construction and numbered to facilitate assembly. The ridges of the gable ended truss roofs were orientated NNE, SSW. Apart from the roof of the stores hut, which was removed at the end of the expedition, these huts are intact.

Bearers of 210x150 mm were embedded 610mm into the ground and held in place by freezing (D. Harrowfield, per. comm. 1998). Floor joists were attached to the bearers and the tongue and groove (T&G) flooring was 100 - 115mm wide by 30mm thick. Wall planks, as well as being tongue and groove, were held in place by steel rods, 17mm in diameter and inserted vertically through pre-drilled holes. A nut, at the top, tightened the walls into a solid unit.

Cross Section of Wall and Floor

The accommodation hut had double thickness walls with a 2mm layer of papier-mache placed between them for insulation. Fur, wool and paper attached to the walls provided additional insulation. The floor was of a similar papier-mache sandwich construction and the ceiling which was 2.1 above the floor, was planked with T&G either side of the bottom cord and under the rafter forming an enclosed loft[vi]. The U values are 0.7 and 1.28 respectively excluding fur etc.
The roof consisted of seven trusses, with scarfed joints, fitted into the notched top wall plank which had the tongue removed. The roofing material was T&G sarking 130 x 20mm[vii] covered with a single layer of canvas held in place by a ridge capping of T&G and under the small soffit by a profile moulding. In addition, six half round battens 50mm in diameter run down the roof to secure the canvas. This canvas extended to the ground on the windward side, which would have assisted the flow of wind over the hut (David Harrowfield per. comm. 1998). Cables 60mm in circumference, attached to ship's anchors and fastened to the hut by iron hooks below the eaves at each corner of the west and east walls provided additional resistance to lifting. Stays were used to stabilize the chimney[viii].

Entry to the interior was via a cold porch (to reduce heat loss) through a heavy, two piece stable door that was hung on ornate hinges, which opened inwards. The decorative inner door with its fine brass handle gave access to the spartan interior although attractive mouldings were used for architraves, scotia and skirting boards[ix].

Campbell's Hut (Scott's Northern Party) 1911-1912

This was a conventional, prefabricated, timber frame, gable end hut of 6.35m x 6.15m, 4.22m high, including the gable of 1.5m, and orientated west-east with a cold porch on the east end. It was of similar construction and materials to the much larger Cape Evans building and possibly supplied by the same London East End Company[x].

Bearers of 180x 180 mm were placed directly on to the leveled ground with 100 x 55mm joists attached. The insulated floor consisted of a layer of 'Gibson Quilting' (an insulating material of finely shredded seaweed between two layers of hessian) covered by 155x20 T&G and a layer of Ruberoid (cellulose fibre mat impregnated and coated with 1mm bitumen). Over this a second layer of T&G was laid, followed by more 'Gibson Quilting' and a top layer of olive-green linoleum[xi]. Bearers of 210x150 mm were embedded 610mm into the ground and held in place by freezing (D. Harrowfield, per. comm. 1998). Floor joists were attached to the bearers and the tongue and groove (T&G) flooring was 100 - 115mm wide by 30mm thick.

The 220mm thick walls also consisted of multiple layers. Weatherboards 165 x 17.5mm (tapering to 5mm) were fixed over a 50mm layer of 'Gibson quilting' and nailed through a vertical layer of 105x10mm match lining into 100 x 50 studs. A sandwich construction consisting of two layer of match lining with 'Gibson Quilting' between formed the interior lining with moulding at the ceiling and floor[xii]. The studs were 750mm apart, mortised and tenon into 100 x 80 top and bottom plates with 110 x 50 dwangs and braces[xiii]. The wall plates were scarfed at the corners.

Three large trusses, each 6.35 x 3.37m, supported the roof. These trusses were constructed of 155 x 75 mm rafters with braces and collar ties and checked for the eight 110 x 60 mm purlins. It is presumed that the roof was similar to Cape Evans with match lining under the rafters to form a ceiling. Match lining was fixed on top of the purlins covered by 2 ply Ruberoid followed by 'Gibson Quilting" and another layer of match lining with the roof exterior being 3-ply Ruberoid. The exterior was bonded with contact adhesive in 600mm wide strips that extended across the ridge and was attached to the top weatherboard[xiv]. The U values were 0.36 for the floor and 0.33 for the walls[xv].

Anchors and barrels of oil acted as fixing points for the two wire ropes that run parallel to the ridgeline. Another tensioned wire rope crossed over the ridge and was fixed to anchors on the north and south walls. A prop was also placed on the west wall for additional bracing.

The initial problem, with this hut, was that it was difficult to assemble without the assistance of a tradesperson. The ships' tradesman, after working for 48 hours, left the scientific and naval personnel to complete the assembly. Priestley wrote *"there was a good deal of truth in the remark that the northern party had for the present turned themselves into a society of making S's out of iron nails"* [xvi]. Where there was difficulty fitting the match lining over the insulation the party resorted to cutting off the tongue of the board and a bulge developed in one wall required strong staying[xvii]. In the first storm Priestley wrote that *"The hut shook and quivered like a thing alive."* [xviii]

Cross Sections of walls and Floors

Destruction of the hut

Although the northern party was aware of the severity of storms at ridleys beach, from borchgrevinks experience, the hut was orientated on an east – west axis facing the high gable into the strongest winds. David harrowfield says that this was partly determined by "……the orientation of the beach ridges and because of the presence of lagoons, the necessity to use high ground. [xix]

Campbell Hut Jan. 1912
Photo J. Dennistoun

As mentioned earlier, the party acknowledged their lack of building experience that resulted in structural defects. Bracing was not fixed at all in some cases (r. Skerton per.comm. 1998) and there is some photographic evidence that the bracing may have been run from the bottom plate to the center of the top plate rather than to the end walls, although this is difficult to establish.

Campbell Hut Feb. 1961
Photo Brian Reid

PREMISE

Using the gable wall to support the roof and reducing the distance between the trusses would have spread the roof load. Rafters would have spread the load more evenly than concentrating the load at six points with trusses[xx].the use of short weather-boards, placing the t&g match-lining vertical instead of horizontal and nailing through the insulation would have reduced the bracing effectiveness of the exterior cladding. With the amount of potential bracing units available the hut should have been able to sustain the wind loads placed on it. It was just that this potential was not used effectively.

Campbell Hut Feb. 1995
Photo Tim Higham

The main structural defect, in my opinion, was the lack of a ceiling diaphragm. The Scandinavian design had a loft for storage. This created problems of stagnant air by reducing the interior volume but produced a box structure that was inherently stable. The British designed hut, although providing up to 50% more air space per unit of floor area[xxi], would be inclined to rack particularly when the gable was orientated toward the strongest wind. The racking of the hut, combined with the weakening of the studs by checking the dwangs (see photo) and the reducing of the bracing effect by nailing though the 'Gibson Blanket' (to reduced cold bridging) would explain the wall fracturing as illustrated. The fracturing of the studs at the bottom dwang line, approximately 750mm up from the floor, (R. Skelton, per.comm 1998) would indicate that a twisting motion was exerted on the building or it was deforming on one side. This would have caused the weakest point to fail, which was where the dwangs were checked into the studs. The higher up the stud the more it was able to deform but lower down it would be firmly attached to bottom plate. A ceiling diaphragm would have eliminated the deformation at the ceiling level. It would not have been necessary to totally enclose the ceiling area but only attach diagonal braces secured to the central trusses. With the walls securely lined the hut would have been able to resist the stresses placed on it by the wind loading.

Current timber preservation problems

Corrosion is an effect that is particular to Polar Regions. Ice at a temperature of -30^0 C assumes the hardness of orthoclase feldspar[xxii] and when combined with high velocity winds it can have a considerable abrasive effect on the exterior claddings. Borchgrevink's huts have been severely affected by weathering to the extent that the cladding thickness has been reduced by up to 70%[xxiii] and rocks of 10 to 15mm have been totally embedded into the timber. The temperature combined with the wind velocity has a particular effect on weathering, wearing away butylclad placed to protect the structures (D.Harrowfield per.comm. 1998). Additional problems include the following:

- Rising seawater
- Ponding of water under the huts that creates a frost heave problem
- The effect of penguin guano on the base timbers
- Increasing pollution (R.Skerton, per. comm. 1998).
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Wall sheared at dwang check point
Photo D.L. Harrowfield

Stud fractured at dwang check
Photo D.L. Harrowfield

Comparison of hut construction:

	Borchgrevink	**Campbell**
Constructed	1899	1911
Orientation	North-south	West-east
Dimensions	Living hut: 6.4 x 5.5 m Stores hut: 5.32 x 5.35 m	6.35 x 6.15 m. excluding porch
Form	Rectangular plan; gable roof	Rectangular plan; gable roof
Structure	Norwegian tradition; plank construction	British tradition; frame with cladding
Foundations	Bearers on excavated gravel beach ridge	Bearers on levelled gravel beach ridge
Walls	60-70 mm thick boards; tie rods	Frame of plates, studs, braces, cladding
Floors	T & G on joists?	T & G on joists and bearers; linoleum
Insulation	Papier mache	Dried seaweed
Anchoring	Wire ropes to anchors	Wire ropes to anchors
Construction problems	None recorded	Various
Conservation problems	Various	Destroyed

David Harrowfield: *The role of wind in the destruction of an historic hut at Cape Adare in Antarctica.*

Conclusion:

The height of Campbell's hut was its main design flaw and this was recognized by *Priestly 'The great height of the hut was obviously a drawback, for it doubled the resistance to the wind and much increased the amount of time taken up with its erection'* [1]. But it has to be acknowledged that durability beyond the immediate use was not a major consideration for Antarctic parties.

The experience of the Norwegians in building adverse weather condition structures has been demonstrated in the well-constructed and sturdy hut Cape Adare hut. The fact that it has survived to the present day is testimony to the fact. Apart from the problems of ventilation and lighting it was adequately comfortable and combined with the additional space of the stores hut and the use of snow tunnels sufficient room was provided to allow the men to work away from each other reducing the stresses experienced by other expeditions.

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