THE TASMANIAN ROYAL ENGINEERS BUILDING
The people who built it and what they did - the good and the bad - their impact on the building and its conservation.

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SUMMARY The Royal Engineers Building was constructed in 1847 using stone excavated from the site of a proposed military excavation intended to protect Hobart from attack by hostile forces.
The building style is a complete departure from the common Tasmanian Military structure of four square Georgian. The standard Georgian construction was however used and the mismatch of the two has affected the building's weathering ability.
The stone used for the building is of low quality , and its poor performance is the result of a unique geology allied to the site specific climate.
The paper explains the building strengths and faults in the light of the personalities of the time and in the light of the scientific analysis underlying the conservation techniques used in restoration.

INTRODUCTION

The Royal Engineers Building is culturally significant because of its historical associations, its siting and its architectural and structural forms.

Historically, it is an important facet of the Royal Engineers role and activities in Tasmania. Its siting on the east-west axis of Macquarie Street appears to have been chosen to provide a grand end to a major thoroughfare and to dominate the city by an army headquarters in Anglesea Barracks at one end and the Engineers Offices at the other.

Architecturally, the building is of Gothic Revival form,which is rare in Hobart.

The building is structurally fascinating. It is a mixture of first class workmanship allied to a mix of good and bad material , and with constructional details which range from sound practice to the structurally questionable. This mix of good and bad is reflected in its first occupants - The Royal Engineers.

BACKGROUND

There is sparse historical information locally available and likely due to the administration of the Royal Engineers from England. The Colony had a history of altercation between the Royal Engineers, the Governors and the Convict Administration. The links between the building and the Royal Engineers can be summarised as :-

* In 1834, Treasury decided to implement its policy of stationing officers of the Ordnance Department in the Australian Colonies.

* In 1825, Captain Roger Kelsall of the Royal Engineers arrived in Hobart to take charge of the Colonial branch of H.M.Ordnance Department. His arrival preceded by one day the arrival in Sydney of the Royal Engineer appointee to New South Wales, and hence Tasmania can claim the distinction of having the first Royal Engineer in the Australian Colonies.

* Kelsall, as Commandant of the Royal Engineers, took over the responsibility for the design, construction and maintenance of all convict and military buildings but excluding civil works which were handled by the Colonial Government. The area covered ranged from Hobart to Launceston, including the towns of Ross and Campbell Town, and extended to George Town and Westbury in the north, to Richmond and New Norfolk in the south and to Port Arthur, Eaglehawk Neck, Point Puer and the Saltwater River Coal Mines.

* In 1836 the first of many clashes between the Royal Engineers Commandant and the Civil Authorities occurred when Kelsall assumed control over all convicts and the produce of their labour. Lieutenant Governor Franklin disputed this assumption and Kelsall and Governor Franklin both appealed to London. They received the Solomonic judgment that the Royal Engineers could control the produce but not the labour and that they (the Royal Engineers) should be responsible to the Lieutenant Governor.

* In 1839 Kelsall advised the Home Office of the defence requirements for river protection of Hobart and Launceston. His advice called for Hobart to have batteries at Battery Point and at Macquarie Point on the western shore and at Kangaroo Point on the eastern shore.

* During the early 1840's the Royal Engineers established their headquarters at Macquarie Point with outstations at Launceston, New Norfolk and Norfolk Island.

* In November 1842, Kelsall, by then a Major, was succeeded by Brigade Major J.C.Victor, who presided over the large works of the Port Arthur Granary (later the Penitentiary), the Macquarie Point and Battery Point batteries, the Port Arthur Hospital, and Barracks at Anglesea Street. He managed to upset two governors, Franklin and Denison, and the Port Arthur Commandant Major Booth, all of whom he out-ranked.

* In regimental procedure the Royal Engineers were second only to the Royal Artillery, so that as a Royal Engineer Brigade Major, Victor out-ranked the 21st in precedence line Royal Scots Fusilier Major Booth, and,as a later promoted Lieutenant Colonel, he out-ranked his two Governors.

* In 1845 the design of the Royal Engineers Building was prepared in Hobart and authorised by the Ordnances annual estimates for 1846-47.

* The designer of the building is unknown,but it resembles St Mary's Hospital built in 1847 and attributed to Kay who was kept on as Colonial Architect after the Royal Engineers were charged with all civil works and Victor supplanted Kay as Director of Public Works.

* The site for the building was Crown Land at Macquarie Point. It was built by the Royal Engineers on land not owned by them but adjacent to their yard. It appears to have been deliberately erected to provide a grand end to the then Macquarie Street and to dominate the area.

* The building was erected in 1847.

* The then Governor was Denison who held the rank of Captain in the Royal Engineers in 1841, arrived in Hobart in January 1847 as Lt Governor, was promoted to Lt Colonel in 1854 and departed in January 1855 to Sydney as Governor in Chief of New South Wales. He retired as a Royal Engineer Major General.

* Victor held the rank of Brigade Major on his arrival in Hobart in 1842, was promoted to Lt Colonel in 1846 and retired as a Major General in1854.

* The design of the Royal Engineers building was copied by the R.E.Commandant Lt Colonel George Hamilton in 1854 when he erected Mayfield in Stoke Street, in conjunction with John May, the Superintendent of convicts. Port Arthur labour and materials were used in Mayfield and a Colonial Government Select Committee found ' stone improperly obtained from Port Arthur, sawn timber from mills intended for Government House, bricks from Government brick fields and prisoners employed on building construction '. Hamilton retired in 1881 as a full General, two ranks above his highest ranked honest fellow Royal Engineer Commandants.

THE BUILDING

Justification for building construction was likely made due to the enormous expansion of the role and work load of the Royal Engineers' establishment in the 1840's. These works were now inclusive of all civil government works in addition to military and convict, together with the provisioning expansion from 500 troops and 4000 convicts in 1837 to 3000 troops and 20,000 convicts in 1847.

The building is two storey in Gothic Revival style and not common in Hobart. It is, to my knowledge, a complete departure from other military constructed buildings which are universally four square Georgian. This departure can likely be attributed to the use of civil instead of military architects and to the take-over of the civil works establishment by the Engineers.

Building construction is of solid brick with ashlar sandstone facing on the west front and north side facades.

It has been suggested that the building is one of the few instances where the Engineers were able to build for themselves.

The building, excepting for the stonework and for odd structural detailing with the use of wood beams over unnecessarily large spans, is of exceptionally sound construction.

There are no foundation defects. The roof structure is unusual in that there is no ridge beam. The roof has had at least two fires in it and the original burnt timbers are still in position with new timbers inserted around them.

The floor construction is typical of prestige buildings of its time with deep joists and lathe and plaster panels between joists at half joist depth and with saw dust filling over to floor level.

There is a very questionable use of timber beams over unnecessarily large spans. Each of the bay windows has two equally spaced mullions, stone on the exterior and timber framed interior, yet timber beams span the full width behind the facing stonework to carry all windows and wall loads above for the full window width.

An even more puzzling structural anomaly is that the setback wall above the front portico was carried on five timber beams across the entire portico, landing in the side walls of the gables each side. The portico has two internal columns and the front doorway has another two columns, yet the wall above is not carried on either set but lands directly on top of door lintels in side doorways, immediately adjacent to the inside of the entrance door.

BUILDING INTERPRETATION

The interpretation is the author's. It is supposition and has no historical reference.

The structural anomalies are not consistent with the works of Major Victor which I have inspected elsewhere. They can, from an engineering viewpoint, be explained by his occupation elsewhere on other works and by his delegation of the design and construction supervision of the building to others. The design is different and the details of projecting windows and wall setbacks require supporting construction different from that normally done by the tradesman used by the Engineers. The end result then is readily explained by an inexperienced supervisor being in charge without expert direction.

The historical record backs up this analysis with writings of Victor pointing out his work load and stating his priorities to be given to military and convict works rather than civil works.

There is no question of the quality of the works or of the materials involved. Both were first class, excepting for the stone as described later. It is only the structural solutions which are inconsistent.

The major structural inconsistency is the lack of support of the first floor exterior crosswall spanning between the two front gables. There are no less than 4 columns at the main door entry yet the wall above is located clear of them. I interpret this as a drafting error not corrected on site due to lack of expert officer level supervision. It is a puzzling circumstance.

BUILDING DEFECTS

The building had major defects with cracking and exfoliating of stonework; of rotation of the first floor wall between the front facade gables; of a black coating to the stoneworks and of missing and removed stonework to cornices, string courses and chimneys.

STONEWORK DETERIORATION

The Kangaroo Bluff sandstone used in the building has been tested both by X-ray diffraction analysis and by a series of hot/cold and wet/dry cycles with sodium chloride solution to simulate actual site conditions. The diffraction analysis showed very high montmorillonite clay levels and rapid disintegration of the stones occurred during the cyclic testing.

The relationship between montmorillonite clay content and poor weathering performance is now well documented with the Triassic sandstones of South East Tasmania. The Kangaroo Bluff stone is the state's worst performing stone. The influence of soluble salts and the site specific environmental climatic effects is not so well known though the basic chemistry and physics can be found in elementary text books.

The formation of salt crystals from a liquid solution in masonry pores causes internal stress as the crystals grow. All soluble salts have this property. The crystal growth pressure is dependent upon the temperature at which it occurs and upon the concentration of the soluble salt. Of the two, concentration is the more important.

Examples are :

Salt	Crystallisation Pressures (atm)					
	C/Cs = 2		C/Cs = 10		C/Cs = 50	
	0°C	50°C	0°C	50°C	0°C	50°C
$CaSO_4$	335	398	1120	1325	1900	2262
Na_2SO_4	292	345	970	1150	1650	1965
$Na_2SO_4 \cdot 10H_2O$	72	83	234	227	397	473
NaCl	554	654	1845	2190	3135	3737

C = solute concentration at crystallisation
Cs = solute concentration at saturation

The particularly high pressures attained by sodium chloride are noted.

Solid crystals of efflorescent salts can change their degree of hydration while in the solid state by absorbing moisture from the air. Sodium sulphate exists as the anhydrous form (Na_2SO_4), the heptahydrate (Na_2SO_4 $7H_2O$) or the decahydrate ($Na_2SO_4 10H_2O$) depending upon the surrounding temperature and humidity.

Changes in degree of hydration cause changes in crystal volume. Sodium sulphate, sodium carbonate, magnesium sulphate and calcium sulphate all effloresce and are regarded as very aggressive.

Examples are:

Humidity	Crystallisation Pressures (atm)		
	Temperature		
%	0°C	20°C	40°C
	$CaSO_4$ H_2O to $CASO_4 2H_2O$		
100	2190	1755	1350
70	1600	1145	702
50	1072	575	88
	$Na_2CO_3.H_2O$ to $NA_2CO_3.7H_2O$		
100	938	611	400
70	448	80	

In general, low temperatures and high humidities produce the highest pressures, high temperatures and low humidities the lowest pressures.

The soluble salts sodium chloride, calcium chloride, magnesium chloride, calcium nitrate and magnesium nitrate absorb sufficient moisture from the air to set up and maintain cyclic crystallisation.

The climatic conditions which favour building corrosion are sea salt spray from a marine location; a large number of wet/dry cycles, a consistent rainfall of showers without heavy flushing rains which occur regularly throughout the year so that crystallisation, partial dissolving, re-crystallisation or hydration changes can occur; evaporation from wind or sun interspersed with frequent light rain; simultaneous high humidity and low temperature.

Hobart has a climate of small monthly rainfall with a consistently high number of rainy days per month. Temperatures tend to be low simultaneously with high humidities. Salt crystallisation curves of sodium sulphate drawn against Hobart climatic characteristics suggest that every day of every month conditions are such that two hydration changes can occur.

It is demonstrated that the Hobart climate is aggressive and is a major contributing factor to building fabric disintegration. It is no wonder that the stonework on the Royal Engineers Building has performed so poorly.

Having said this, the original Royal Engineers, Kelsall and Victor, had no knowledge of these effects and could not have even imagined the consequences of their actions.

ROTATION OF FIRST FLOOR WALL

This wall was supported off four timber beams. The first and second beams to the exterior had extensively rotted and their compression caused the wall to rotate.

The beams were replaced with hot dip galvanised universal beams with a flashing over to prevent water entry. The wall was needled and jacked up slightly to enable removal and replacement. The exercise went smoothly and all original wall fabric was left undisturbed.

BLACK COATING TO THE STONEWORK

Some small surface exfoliated sections were taken for laboratory microscopic analysis.

It was found that a uniform continuous black coating covered all the sandstone surface grains with penetration to 0.25mm to 0.55mm below the surface with less than 0.01mm thick coat to individual grains. The coating was found to be confined to this layer with no penetration below and to consist of an oil residue interspersed with algae and lichen.

Tests were conducted with light abrasion using machine tools and hand brushing and with pressure water sprays. Detergents and solvents were not used so as to not drive soluble material into the stone.

Best effect at least cost was using stainless steel wire brush by hand and the whole of the building was effectively cleaned.

MISSING AND DAMAGED STONEWORK

Original photographs were used to determine size, dressing and shape of missing stonework. A search of previous research records showed the north east Tasmania sandstones to be free of montmorillonite clay and the Nunamara Quarry from the slopes of Ben Lomond was found to have a colour variation from off white to buff which closely matched the weathered stonework of the building. Nunamara stone has subsequently been used as a replacement stone for all faulty stonework.

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