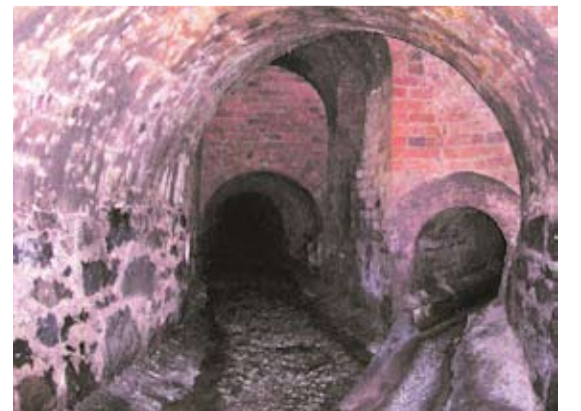
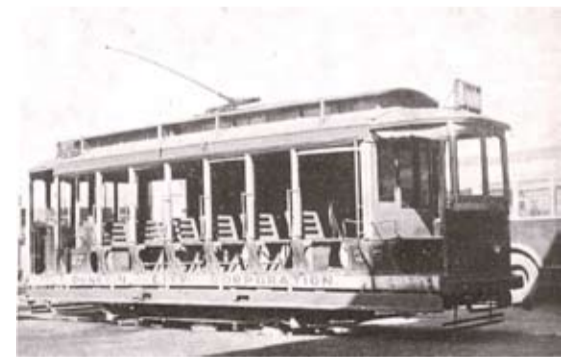


Dunedin's Engineering Heritage Trail

Recognising the vision, skills and tenacity of early Engineers that were pivotal in the city's development and early prosperity.

Walk 2 – The Exchange Route

2.5km—1.5Hrs



Introduction

When telling the stories behind buildings, structures and machinery, there are a number of different slants that a researcher can take. Often, the emphasis is on the architecture, the scene or the social history. This brochure reflects the stores from an Engineering perspective. However, like so much in life, the subject matter doesn't fall neatly into categories and for some sites we need to consider the role of other professions and aside from our own. But with the theme being Engineering, we won't dwell on cosmetic details or personalities, instead recognising the significant skills, concepts, technologies and visions associated with each point of interest. The term Engineering has much wider scope than most people realise, including Structural, Fire, Civil, Hydraulic, Electrical, Mechanical, Telecommunications and Transport. Therefore, the IPENZ Heritage Chapter has prepared these walks to give a sample of the city's rich past while demonstrating as many different disciplines as possible.

Colonial settlement of Dunedin began in 1848 when Scottish Presbyterians arrived. The Gabriel's Gully gold rush of 1861 brought thousands of miners and much wealth to Otago. Dunedin became the largest city in New Zealand and there was an increasing demand for engineering services to create infrastructure for the expanding population and to support the mining and transportation industries.

1 Otago Settlers Museum

The Otago Early Settlers Association was founded in 1873 to commemorate the first 25 years of planned European settlement in Otago. The oldest building on this site was opened in 1907 as an Art Gallery. The adjoining Settlers Hall opened 1908. They were designed by Architect Arthur John Burnside and built by Mr Orr Campbell. The Donald Reid wing was built by Loan and Watson and opened in 1922. Josephine was moved into this wing in the 1960s. In 1991, the Dunedin City Council took over the old Early Settlers Museum and in 1992 the council purchased the Railways Road Services building. The Council undertook extensive work to strengthen the old buildings and linked them to the newer bus depot.



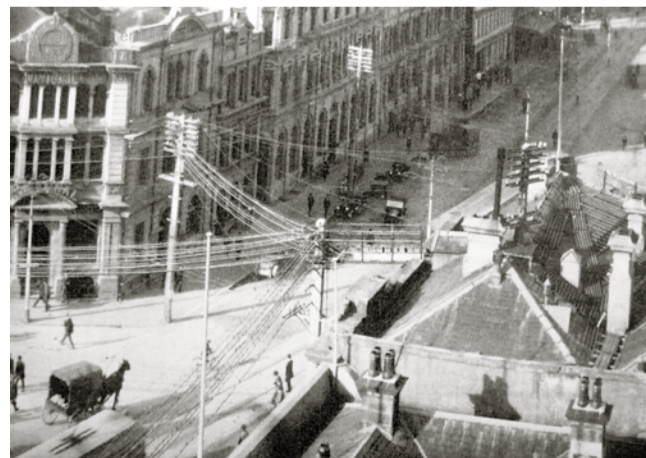
national competition. The bus depot opened in November 1939. It is an art deco design. The walls are finished with pinkish-brown Hammer Marble, Belgian Black Marble and NZ Green Serpentine Marble. The site shape is unusual, being a triangle 123 m long by 52 m at its widest end. A significant design feature is the way the buses were able to drive around the main concourse. There was garage space for 25 buses. The main engineering feature is the welded steel trusses over the former workshop area which are up to 33 metres long and all are different lengths because of the site's shape. The building is largely made from reinforced concrete.

17 Plane Table behind First Church

The base for this is made from the foundation stones of an 1850s Presbyterian Church that used to be in Dowling Street. From here, it is possible to look back at the features we have visited, such as the reclaimed areas, Queens Gardens and the Otago Settlers Museum, as well as the railway, industrial area, wharves, harbour, causeway and Peninsula road (built by Maori captured at Parihaka) with its wave protection rock walls (revetments). Each have their own history which has engineering significance entwined in it.

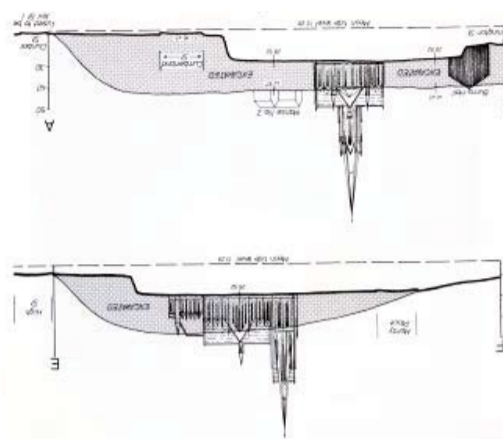
Otago Settlers Museum displays

The walk ends at First Church but you can return to the Settlers Museum and look at some of the displays there. The main engineering displays relate to early transport including locomotives Josephine and JA1274, a cable car, coach, bullock wagon, cars and bicycles. There are also computers and historical records.



This brochure has been produced by The Institution of Professional Engineers (IPENZ) Engineering Heritage Otago Chapter with assistance from Otago Settlers Museum and DCC Community & Recreation Services. *Recognising achievements in engineering, industry and technology in Otago & Southland.*
www.ipenz.org.nz/heritage

The influx of both ships and people to Dunedin in the early 1860s following the discovery of gold inland, created a pressing need for more flat land around the harbour to accommodate the commercial expansion. The Provincial Government decided that Bell Hill, which despite the Princes Street Cutting was still a massive barrier in the centre of town, should be demolished to provide spoil for the reclamation work. The earthworks were undertaken using a mix of private contractors and prison labour. At times up to 500 men were working on the project which



The original shoreline followed the foot of the hills that you can see from the Museum. It is also indicated in blue on the map. Early paintings and photographs show that a prominent hill dominated the centre of Dunedin. It was too steep for wheeled vehicles to cross and sloped too sharply into the Harbour to allow a road to pass around it. The shoreline at that time was at the base of the cliff near Lower High Street and Dunbar Street.

2 Bell Hill, The Cutting and Reclamation

Shortly before 1900, the Otago Harbour Board became deeply concerned at the discharge of wastewater to the Otago Harbour. In response to a request to stop this discharge, the Dunedin Drainage and Sewerage Board was formed and charged with developing a strategy to address the issue. They opted to construct a main intercepting sewer near the shoreline of the day, with that sewer discharging at the pumping station then pumped the flows up to the outfall at Musselburgh Pumping Station, the lowest point in Dunedin. That in 1903 and is approximately 5 metres deep and ranges in diameter from 1.0 to 1.8 m. The pipeline is extraordinarily flat; one metre of fall per 3 km of length. The separation of the sewer system (giving separate pipelines for wastewater and stormwater flows) was completed in 1986. The main intercepting sewer remains in good structural condition. However there are areas of settlement where the pipeline is constructed in compressible harbour silts.



proceed along Princes Street. wide cutting into the solid rock to enable wheeled traffic to 1858 the first attack on the hill was made by blasting a six-metre



Beneath the Queens Gardens

3 Main Intercepting Sewer

involved blasting the rock and shovelling it into horse-drawn trucks which ran on rails; to discharge their loads on the tidal flats. On the newly reclaimed ground, streets were formed by the Provincial Government and handed over to the City Corporation

16 First Church

A Church Reserve was established here by the first settlers in 1848 but construction of the current building wasn't commenced until 1867 as the site was lowered to provide fill for reclamation work (there was initial concern that the lowering of the hill would reduce the church's prominence). The design competition for a church was won by Robert Arthur Lawson. It has seating for 1,000 people. Construction was undertaken by D & J Hunter, Builders, for £14,000. It was completed and opened in 1873.

The building's overall length is 46 m with a spire height of 53 m. When originally built, the top portion of the spire was slightly out of perpendicular and 4.6 m too short so had to be rebuilt. The exterior walls of the church are brick, lined with Oamaru stone, making a solid wall about 500 mm thick. The tower and spire were similarly constructed, the spire being hollow for about two thirds of its height, with the remainder solid.



Major repairs were carried out in 1890 after all the bearing timbers were found to have dry rot due to bad detailing. The beams were replaced and other repairs were carried out, including repointing the Oamaru stone. The roof was raised and supported by a 15 metre Oregon spar during the work.

In 1873, 1924 and 1930 high winds blew down some of the spire pinnacles and damaged others. Repairs were carried out in 1933. The tower was strengthened with galvanised tie rods in 1964/65 and these were replaced with stainless steel rods in 1990. J R G Hanlon was the Structural Engineer for the latest strengthening and W H Naylor was the contractor. Four pipes in



the outer vestibule are obvious signs of this work, as are the six stressed cables below the ceiling and plates on outside walls.

4 One way street system

The one-way concept was developed by a traffic engineering partnership of De Leuw Cather from the United States and Rankine & Hill of Australia in 1964. The City Engineer's department undertook the design and implementation of the project. The City Council adopted it after very extensive public consultation and liaison with the National Roads Board, in the face of strong opposition from retailers, newspapers, the Otago Hospital Board and others, which meant physical work didn't commence until 4 years after the original report was received. All opposition ceased a few days after the system opened, clearly because of the dramatic improvement it had on traffic flows throughout the central city and beyond.

5 Cumberland Street Overbridge



Photo: Otago Daily Times Archives

The first bridge over Cumberland Street was one block south of the present one. It had riveted steel plate girders and was constructed in 1886 by the Dunedin firm of Kincaid, McQueen & Co. Castings for the bridge were made from the first steel produced commercially in New Zealand at Smellie Brothers' new iron works at Burnside, Green Island. Smellie Brothers became the Otago Iron Rolling Mills which operated until 1953 and eventually evolved into the current Farra Engineering. The new prestressed concrete bridge was opened in 1977 and the old bridge was removed soon after, although the old masonry abutments are still visible.



9 Chief Post Office

This building was designed by John T Mair (the Government Architect) and built by the Fletcher Construction Company Ltd. Foundations were laid in 1929 and the construction during the 1930s depression gave employment to workmen and added impetus to business generally. The riveted steel girder frame was encased in concrete and was said to be earthquake-proof (the first in Dunedin). The building was fitted with electrical and mechanical devices of all kinds and it was a striking illustration of the progress made in engineering and electricity. These features include a Vigilant fire alarm system which was invented by Dunedin Post and Telegraph Department staff member, Matthew Moloney. The completed building housed a number of Government Departments as well as the Post Office (Post and Telegraph) such as Lands & Deeds, Lands & Survey, Customs, Health, and Public Works. Radio Station 4ZB had its studios and equipment on the third floor.



Photo: Dunedin Post Office 1935 Fletcher Challenge archives

10 Shoreline Plaque

This plaque marks the landing place for the first settlers in 1848. The land on the harbour side of this point was reclaimed with material from Bell Hill.

11 Grand Hotel

This building now houses the Casino and is surrounded on three sides by the Southern Cross Hotel. The architect was Louis Boldini. It was built in 1883 and clad in Oamaru limestone. It is constructed of fireproof material (a marketing factor) and also featured an example of the recently invented electric lift.

12 The Exchange—A Transport Terminus

This area is the earliest major transport hub in Dunedin. Horse trams commenced in 1879. Operation of the legendary cable cars began in 1881 with the final service terminating in 1957. In 1903, electric trams commenced operations along Princes and George Streets, replacing the horse trams. Dunedin had more tramlines in proportion to population than any city in the world. In 1952, trolley buses started to replace the tram services and the change was completed in 1956. The first diesel buses were introduced in the 1930s to supplement the other modes, with a full changeover being achieved in the early 1980s.

6 New Zealand Express Company Building

This building is now known as Consultancy House, formerly known as the NZ Mutual Funds Ltd (MFL) Building. It is one of the very early reinforced concrete multi-storey buildings in New Zealand and was built in 1908 for the NZ Express Company Ltd (a transport and cartage company). The building was designed by the Christchurch architectural firm Sidney & Alfred Luttrell and built by Charles Fleming MacDonald. It was the tallest building in the city (at that time) and incorporated many features which were very advanced for its time, some of which weren't used widely until many years later. Some of these features included a central heating system using hot water distribution and radiators from a single boiler, possibly NZ's first reinforced concrete raft foundation (containing 250 tons of reinforcing) to overcome the problems of building on the old foreshore and precast concrete floor slabs. The reinforced concrete structural frame design was proof tested by loading full-sized models of parts of the structure to destruction. It is possible to walk through the east entrance of the building, view the construction plans on the wall and exit onto Bond Street on the other side of the building.



Photo: Otago Settlers Museum collection

13 Cable Car Underground Chamber

There is an underground chamber beneath the surface of High Street near the entrance to the Southern Cross Hotel that has an interesting history. It started life in 1883 when it was built as part of the Mornington Cable Car line up High Street. It housed the large pulley for the continuous cable that ran from the engine house in Mornington. Cable cars gripped the cable and were pulled up the street and lowered down.

During the 1950s, the electricity supply system to the CBD was upgraded, which included installing a series of underground substations, one of which was located in the pit. This was a tricky task as the pit was close to one of the City's main sewers, and was covered in 75 years of grease spilt from the axle bearings of the pulley. Interestingly, the entry is via a side tunnel

7 T&G Building

The structural design of this building (now named Upstart House) was carried out in 1955 by Tom Paulay of Bruce - Smith and Associates (Consulting Engineers, Wellington). He was aged 32 and had graduated from the University of Canterbury only two years earlier. The building was designed to be 11 storeys high which was then considered to be a high-rise structure. Professor Paulay says, with the benefit of hindsight, the state of the art of seismic design in 1955 was rather primitive. Fortunately it was conservative and the seismic strength of the building is about three times that aimed at now. It was designed with strong beams and weak columns, in contrast to the current practice of strong columns and weak beams.

By the time tenders were called, the client realised that the space in the 11 storey building was in excess of the demand in Dunedin at that time so construction stopped at the seventh floor. Prof Paulay is disappointed at the appearance of the resulting "beheaded stump".



8 ANZ Bank Building

The building was constructed in 1874 for the Union Bank and designed by the architect Robert Arthur Lawson. The Union Bank was the first bank in Dunedin. The interior was reconstructed in 1976 by Naylor Love and that work was designed by the late David Cox of Brickell Moss Rankine and Hill. Prestressing cables behind the columns hold them down. There is a concrete diaphragm just above the sill of the first floor windows and steel trusses in the roof space.

from a manhole cover in the footpath. The old brick walls of the pit had to be underpinned and deepened to accommodate the electricity transformer and switchgear. A large hatch in the centre of the roadway provided access to lower the transformer into place, and a large fan and grill was installed for ventilation and to dry the renovated pit. It is no longer in use.

14 Bank of New Zealand Building

The present building replaces an earlier one built in 1863 for the Bank of New Zealand. It was itself a significant building but not large enough, so was replaced by the present building. Construction commenced in 1879 and was completed four years later. The architect of the first Bank building was William Mason who became the first Mayor of Dunedin.

The present building was designed by William Armson and constructed largely of Oamaru stone. It was vacated by the BNZ in 1999 (after 116 years) and has been used periodically for a number of purposes since that time, including as a temporary courthouse while the main court building was restored. There are plans to convert the building into apartments. The exterior of the building is largely unaltered. In the basement, where the walls are 1.89 metres thick, there was an hydraulic lift servicing upper floors and the usual strong rooms as well as smelting rooms originally built to handle the gold trade of the province.

15 National Bank Building

This 1912 building was designed by William Henry Dunning. Charles Fleming MacDonald was the Contractor who commenced work following completion of the NZ Express Co Building. It is made of reinforced concrete with Melbourne trachyte (lower storey) and Sydney Sandstone (upper stories) stone facade capped by an expressive pediment. The floors were poured in situ. The banking chamber is 25 x 16 metres, free of columns and had a glass dome that was later removed. Some alterations have been carried out recently as part of a restoration process, including structural strengthening at basement level.

In 1998 the building was vacated as a bank and then sold. Through to 2004 the new owners redeveloped the building using adaptive reuse techniques and conservation principles. A prime objective was to restore the banking chamber, one of the city's most impressive public spaces, using sustainability principles.

The new energy efficient rooflight replaces the original use of natural light. The strengthening at basement level enabled conversion of the bank vaults into basement car parking.