

West Gate Freeway – by David Jellie

[Editor's note: David Jellie has provided this excellent first instalment of the history of the West Gate Freeway. He told me:

Richard Warwick suggested that we should develop some brief histories of some of the CRB/RCA/VicRoads projects, and I was asked if I would do the West Gate Freeway. I had an involvement in the construction of the approaches to the bridge on both sides of the Yarra River.

Although West Gate Bridge was not part of the history of CRB/RCA/VicRoads it looms so large in our history, I decided to record its story also. It was the bridge that created the stories of the approaches, and the freeway is now one of Australia's busiest roads.

In telling the story of West Gate Bridge, I was very fortunate to find some professional photographs taken by our member, Rob Morgan, when he was an engineering student. They are a very valuable record, and he has kindly given me permission to publish them.

This is the first instalment. It is about the history of the bridge itself. I will provide later instalments about the construction of the approaches.]

The West Gate Freeway links the Princes Freeway in the west to the Monash Freeway in the east – a distance of 13.7 km. Its most prominent feature is the West Gate Bridge over the Yarra River.



This schematic map shows the West Gate Freeway extending from the Princes Freeway in the west to the portal of the Burnley Tunnel in the east. It also shows the later connections to the West Gate Tunnel, CityLink and the Monash Freeway east of the Burnley Tunnels.

A crossing of the Yarra River to connect the City of Melbourne to the west goes back to 1888 when Victoria's Public Works Department proposed a tunnel under the river. In the meantime, various ferries operated from Fisherman's Bend to Newport - up until 1974. Other proposals were tentatively considered but it wasn't until 1957 when more determined action was initiated by the Western Industries Association which represented major industries in the western suburbs.

The Association formed a sub-committee to investigate a crossing of the Yarra, and in 1958 it asked the Victorian Government 'to give urgent consideration to construction of a traffic tunnel under the Yarra.' The Association had been told by shipping interests that a bridge would not be acceptable for the crossing. The tunnel, it was suggested,

would carry 30,000 cars a day; differing estimates on the capacity of the 'overtaxed' ferry suggested it could only handle between 1,200 and 2,000 per day.⁵

The Victorian Government's response to the proposal was that its finances were inadequate to undertake a crossing urgently and that any such project would therefore require private investment. In 1961, the Lower Yarra Crossing Limited was formed. It was a non-profit company whose mission was to develop a concept for the crossing and its subsequent implementation.

In 1964, a committee was appointed to examine the question of whether a crossing should be made by way of a bridge, which would be sufficiently high to keep the river open to shipping, or whether it would be more appropriate to construct a tunnel. The committee failed to agree on this question, but the Government eventually decided that the crossing be a high-level bridge.



The Williamstown Ferry – circa 1971.

In 1965, the Lower Yarra Crossing Ltd went into voluntary liquidation and a new company was formed called the Lower Yarra Crossing Authority Limited (LYCA). The Lower Yarra Crossing Authority Act 1965 (No. 7365) vested the Authority with certain powers, the general purpose of the Act being that it would be able to borrow money on debentures, to finance the construction of the crossing.

It was given the necessary powers for the compulsory acquisition of land and to impose tolls on the bridge to enable it to repay the debenture debt the company raised. Thus, the bridge would be paid for by those using it, and eventually, it would become the property of the Crown.

⁵ West Gate Freeway now carries over 200,000 vehicles each day including a high percentage of freight vehicles.

The LYCA engaged a world-renowned British consulting firm, Freeman Fox and Partners (FFP), to design a cable-stayed bridge. FFP specialized in the design of large, steel bridges the most notable of which was the first Severn Bridge (main span 988 m) opened by Queen Elizabeth II in 1966. The Severn Bridge is a motorway suspension bridge that spans the River Severn between South Gloucestershire in England and Monmouthshire in South East Wales.



View of the Severn Bridge designed by FFP and opened in 1966.

The founding partner of FFP, Sir Ralph Freeman, played a leading role in the design of Sydney Harbour Bridge and the Victoria Falls Bridge over the Zambezi River on the border of Zambia and Zimbabwe in Africa. Both these bridges are long span arch bridges. His successor in 1950, his son, also Sir Ralph Freeman, was instrumental in the design of the Forth Road Bridge in Scotland – at the time, the longest suspension bridge in Europe.

While these famous steel bridges may have demonstrated FFP's credentials to design a crossing of the Yarra – as an arch or suspension bridge – they chose a design for a cable-stayed bridge, steel box girder bridge. West Gate Bridge featured the world's longest cable-stayed steel box girder span, measuring 336 m. It was a pioneering engineering project for its time. This type of structure for long-span bridges was just coming into vogue although versions of cable-stayed bridges date back to the 19th century (and earlier). The steel-decked Strömsund Bridge in Sweden (1955) is generally cited as the first modern cable-stayed bridge.

A cable-stayed bridge is a type of bridge that has one or more towers, from which cables support the bridge deck. A distinctive feature is the cables or stays, which run directly from the tower to the deck, normally forming a fan-like pattern or a series of parallel lines. This is in contrast to the modern suspension bridge where the cables supporting the deck are suspended vertically from the main cables, which run between the towers and are anchored at both ends of the bridge.

The cable-stayed bridge is optimal for spans longer than cantilever bridges and shorter than suspension bridges. This is the range within which cantilever bridges would rapidly grow heavier, and suspension bridge cabling would be more costly.

The bridge was over 2.5 km long, 37 m wide (to accommodate eight lanes of traffic) and nearly 60 m above the Yarra River, allowing the passage of sea-going vessels between Hobson's Bay and the dock complex upstream.

The structure is founded partly on piles and shallow footings on basalt rock, but principally on cylinders carried to rock 40 to 60 m below natural surface.

The substructure comprises concrete piers. The two towers supporting the main spans are steel and they rise 45 m above the deck to a height of 103 m above water level. The pier spacing for the river span is 336 m. The superstructure is of steel cable-stayed box girder construction for the central five spans, and pre-stressed concrete box girders elsewhere.



The eastern concrete approach spans being built, viewed from near Todd Road – May 1970.
(Image courtesy of Rob Morgan ARPS)

Construction of the bridge commenced with an air of anticipation, pride and optimism. But beneath the grandeur and elegance of the iconic bridge lies a tragic story that will forever stain its achievement.

During construction on 15 October 1970, a span of the bridge collapsed killing 35 men and leaving many more families shattered. The collapse was sudden and devastating - killing people on the ground below the bridge as well as many who were on the deck. It remains Australia's worst industrial disaster.



The 2,000-tonne section of the bridge that collapsed in 1970.
(Image courtesy of the Public Records Office).

A Royal Commission was appointed to investigate the causes of the disaster. It published its results in August 1971 and found that the collapse was caused by a combination of critical design flaws by FFP and unsafe and unconventional construction methods by the contractors, World Services and Construction. The report, chaired by Mr. Justice Barber, highlighted a fatal "constant sense of urgency" to meet deadlines, which compromised safety and led to disastrous attempts to correct a buckle in the structure.

The Key findings of the Royal Commission can be summarised as follows:

- **Immediate cause:** The collapse was triggered by the removal of a large number of bolts from a transverse splice in the upper flange plating of span 10-11, an attempt to fix a buckle in the steel that had been caused by heavy loading (kentledge) to correct camber errors.
- **Design failures:** The Commission criticized the design for having an insufficient margin of safety.
- **Construction failures:** The methods used for assembling and adjusting the steel spans were deemed improper and dangerous.
- **Management and communication breakdown:** A major contributing factor was the poor communication between engineers and contractors, along with a, "failure to make adequate inspections".
- **Urgency pressures:** The report highlighted that the relentless pressure to complete the project on time created an environment where safety was overlooked.
- **Split responsibility:** The project suffered from a complex, divided responsibility structure between the designers and contractors.

In addition to these findings was the constant pressure by the trade unions – especially on demarcation issues – which slowed progress and caused alienation between the parties.



View from the eastern viewing point. Span 10-11 which collapsed in October can be seen in its two halves: the north half up on the piers and the south half jacked up to near full height, ready to be rolled across. (Image courtesy of Rob Morgan ARPS)



View from the eastern viewing point. Span 10-11 has collapsed, knocking over Pier 11. (Image courtesy of Rob Morgan ARPS)



The fallen span beside Stony Creek, with Pier 12 on the left.



Looking down onto the fallen span from the top of Pier 10.
(Images courtesy of Rob Morgan ARPS)

Many warning signs were ignored during the lead up to the collapse.

A 110 mm difference in camber was discovered where two halves of the box girder met. Instead of placing a hold on work, ten eight-tonne blocks of concrete kentledge were used on the north side of the joint in an attempt to deflect the edge to align with the edge on the south side.

This led to further buckling, and when the central bolts holding the joint together were removed, the collapse was precipitated.

Just months earlier, another steel box girder bridge under construction at Milford Haven in Wales collapsed, killing four workmen. This bridge was also designed by FFP.

Naturally, the West Gate construction crew were especially worried as they too were experiencing similar problems. FFP's response was to fly the project's head engineer and designer to Melbourne to reassure

workers that the bridge was safe. A meeting was held, a vote was taken, and everyone went back to work.

The toxic culture on the project inhibited open discussion of problems. It is reported that some workmen noticed things which should have been cause for a red flag but the hierarchies on the site at all levels mitigated against remedial actions. Health and safety measures were inadequate and the various parties should have had in place a communication system that encouraged all personnel to air their grievances without fear of retribution. This is at both a working level and a management level. Things were hidden from view and as they cascaded one upon the other, the disaster continued to build and eventually rolled out with the inevitability of a Greek tragedy.

The Royal Commission stated that “Fundamental to the whole sorry situation was a constant sense of urgency and pressure to complete the construction within specified times.” It also noted: “No one can blame the Authority for a desire to keep its contractors up to schedule... Nevertheless, the determination to keep the work moving at all costs was so extreme as to engender an atmosphere in which speed was all-important consideration.” This urgency also hampered and discouraged communication to the detriment of the integrity of the structure and the safety of the workforce.

I am also of the opinion that the designers were too far from the site. The bridge was designed in England and being built in Australia thus preventing the designers and builders working in close collaboration. Designing a bridge for service conditions is only one aim, as bridge components may experience greater stresses due to construction sequences and techniques and these need to be taken into account. The distance between the designers and builders was too great to allow this to happen – keeping in mind that communication systems were far less efficient than we enjoy today. There were no services such as email and fax available at the time.

Dare it be mentioned, I suspect there was a colonial master and servant relationship that pervaded FFP’s relationships with the Australian parties. With their international renown and reputation, there may have been an attitude of ‘We know best.’ Certainly, Sir Ralph Freeman’s appearance at the Royal Commission was unhelpful and somewhat aloof.

Following the publication of the Report of the Royal Commission in August 1971, the Lower Yarra Crossing Authority⁶ formed its own Directorate of Engineering to be responsible for the re-design, supervision of construction, and contract administration of West Gate Bridge until its completion.

Intensive reviews of the structure focused attention on the inadequate strength of the original design of the bridge's deck. This consisted of a 100 mm reinforced concrete slab acting compositely with a steel plate stiffened by bulb flats. Numerous proposals were examined and the final solution was to replace the original steel and concrete deck by a lighter and stronger orthotropic steel deck. This orthotropic deck is a steel plate stiffened longitudinally by closely spaced cellular troughs and laterally, at intervals, by cross beams.

A Proof Engineer from Germany (Professor Karlheinz Roik) was appointed to independently check the re-design of the bridge in accordance with the recommendations of the Royal Commission. The re-design was also checked against

⁶ The Lower Yarra Crossing Authority changed its name to the West Gate Bridge Authority in 1974.

the German code and the Appraisal Rules of the Merrison Committee's reports.⁷ The re-design was also endorsed by four other university professors of civil engineering: F.B. Bull (Adelaide), N.W. Murray (Monash), J.W. Roderick (Sydney) and L.K. Stevens (Melbourne).

Following design alterations, reconstruction of the West Gate Bridge recommenced in 1972, and was finally completed in 1978, at a cost of \$202 million - over eight times the original estimate.



An aerial view of West Gate Bridge – date unknown

David Jellie. April 2026

⁷ The 1970–1971 Merrison Committee, chaired by Sir Alec Merrison, was established by the UK government following fatal collapses of steel box girder bridges at Milford Haven in Wales and West Gate. It revolutionized structural engineering by introducing stringent Interim Design and Workmanship Rules, which mandated independent design checks and safer construction methods.