Hammerhead Crane, Garden Island, NSW

A good Meccano model project by Mike Wright

A general view of the crane. Similarities to the prototype of the pre war super model are apparent in this view.

Location

The crane is located at the Fitting Out Wharf, Gore Road, West Fleet Base of the Royal Australian Navy, Garden Island, Woolloomooloo Bay, Sydney

History

Taking seven years to build, it was at the time the largest crane in the Southern Hemisphere. Being built to lift warship engines, boilers, gun turrets and guns of up to 250 tons, it is also a historic reminder of the massive facilities necessary to regularly service naval forces half a century ago.

The crane occupies a length of 52.1m (171ft) on the fitting out wharf about two-thirds along the Captain Cook Dock, beyond the boundary of Garden Island itself. Although the crane is incorporated into the wharf, it is disconnected from it by expansion joints on either side of its abutment with the wharf.

The crane remains the largest dockside crane in Australia. Like the dockyard itself, it was engineered to the extremes of likely demand and represented the contingency approach to naval support planning in the aftermath of the two World Wars. Tenders for the crane were called in 1944 and it was constructed between 1944 and 1951.

Construction

The Sydney Steel Company Pty Ltd was contracted to fabricate and erect the crane to the design of Sir William Arrol, with Sir Alexander Gibb and Partners as consultants. All mechanical and electrical equipment came from England and all structural steelwork was fabricated and erected by the Sydney Steel Company. The crane's main function was the removal and refitting of gun turrets to warships. It was last used in 1988 for heavy lifting of power station stators (the cores of electrical generators). Upon completion in February 1952, the Minister for Works, the Honourable J. J. Cahill, drove in the final rivet to complete the edifice. According to an undated brochure published by the Navy, the Hammerhead Crane first came into use in March 1951. According to the specification, all fabricated steelwork had to be assembled and then trial erected to check the faring of holes and camber of booms. At the time of trial erection of the cantilever and during preliminary checking for camber it was found impracticable to build the cantilever the right way up. This would have necessitated a great deal of shoring because the jib tapered from 11.28m (37ft) in the centre to 4.6m (15ft) at the nose. It was decided to build the cantilever upside down as the top chord only had a camber of 20.7cm (8 5/32in). Pre-cast concrete blocks were placed at each panel to give the correct camber and trial erection then proceeded satisfactorily: all splices being 60% pinned and bolted using parallel pins so as not to damage the holes. After the trial erection ended, the structure was dismantled and transported to the site for final erection.

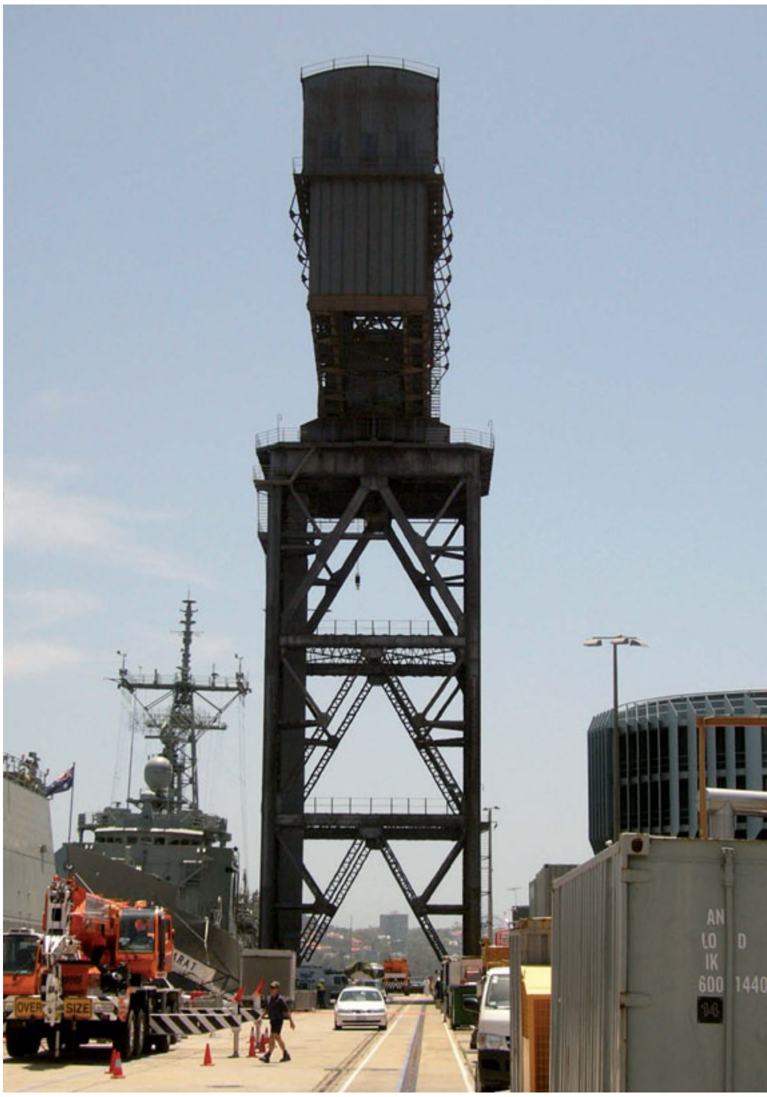
Work commenced on the foundation cylinders in August 1944 (each of the four cylinders were named (A to D). In March 1945 the precast sections B and D each weighing 146.8 tonnes (144.5 tons) were lifted and placed in their prepared guides using the floating crane Titan. They proved watertight but were extremely lively in the water, the slightest wash from a passing launch causing them to strike heavily against their staging. Work on the foundations continued but water penetration of cylinders A and C became a concern caused by general seepage and then by small leaks. By 19 August 1946, the Engineer in Chief reported: 'Water was coming in fairly rapidly...' and on 24 August two divers worked in relays plugging the leak, but the depth was great and the job was not successful. Divers working in 31.4m (103ft) of water could only generally work for a total time of 2 hours 50 minutes in two descents per day. By Saturday 31st August, cylinder water penetration had interconnected cylinders A and C. They were '... found to be leaking badly...' in his article of March 1952 Mr Bickford, the Engineer in Chief said: 'The afternoon shift persevered with the plugging and bailing throughout the Saturday night, doing a 15 hour shift. On Sunday morning, 1 September, the morning shift worked 12 hours and the afternoon shift carried through till 6.30AM on Monday, 2 September, in spite of the men being continuously wet. This dogged perseverance of the miners and the engineers saved the situation.' Work continued and by 18 September 1946 the cylinders were de-watered. The Engineer in Chief subsequently reported: '...No leakage was apparent against the cylinder walls and only one of the four relief pipes showed a slight drip...'

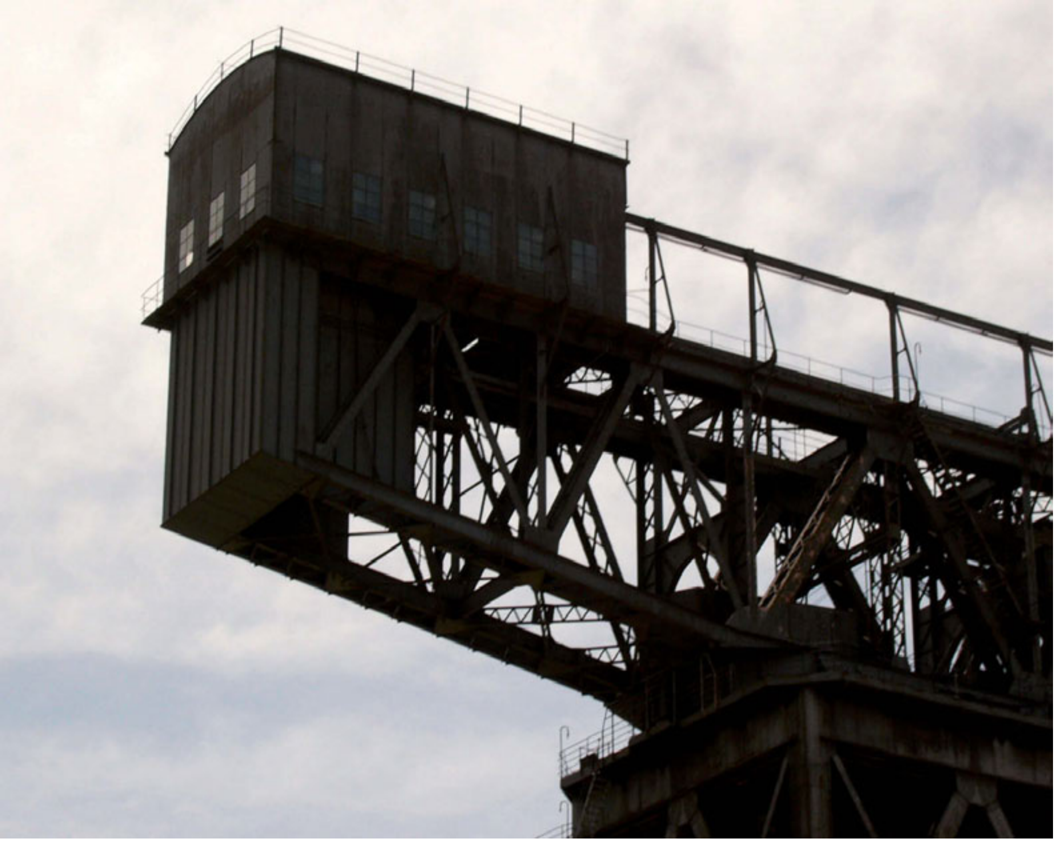
Erection then proceeded with diagonal bracing for the tower. This procedure was carried out until the 45.6m (149ft 9in) level was reached and then owing to the limitations of the 40.64 tonne (40ton) erection crane, the erection was differently set up. After checking for plumb and height, riveting and preparation for the four main girders to receive the roller path began, the roller path was measured using a theodolite to .0127cm (.005 in) and pairs of steel fox wedges were driven in. The track was then fastened to the main top tower girders followed by the spur wheel and then the rollers were placed in position. Ninety-six 41cm (16in) diameter solid steel rollers were fitted together to make a spider or live ring running in between the top and bottom track plates. Simultaneously work began on the underside of the drum girders to receive the top track plates. These two girders were of such a large diameter (15.2m diameter and 76cm wide) that it was impossible for any machine in Sydney to work on them. Eventually a special tool was made to complete the task. It is claimed this machining was brought to an accuracy of 0.127cm (.050 inch).

After this operation was completed, the track plate was then bolted down to the girders and the pivot girder and drum girders were then erected on the tower and a single centre pin and nut were locked in position. The centre pin was 46cm (15in) in diameter.

When the ends of the short booms were erected, ie, 29m (95ft) from the centre pin to the end, the ballast box was placed in position and the ballast inserted to balance the erection of the long arm of the jib. The ballast consisted of 279.4 tonnes (275 tons) of cast iron billets which were positioned in accordance with a plan set out by the Engineer. The main machinery house on the top of the short arm was then erected and also the control tower, which was suspended between the two booms towards the nose of the crane.

The main winding drums for the 127 tonne (125 ton) hooks were 18.3 tonnes (18 tons) in weight, made up in three





The three illustrations above give a progressive three quarter view of the boom from the engine house to the tip of the boom. There is sufficient detail to enable a builder to reproduce the number of bays and the bracing. Left: Rear cantilever and engine house. Centre: Tower head, turntable and jib centre. Right: Forward boom showing crab and bracing structures. Below right: The traveller and lifting tackle.

sections. Concurrently the electrical machinery was installed. The main power was 415 volt 3-phase and all wiring was of 660 volt capacity. The main power was taken through the hollow centre pin in an armoured and lead covered cable.

Approximately 1.28km (1,400 yards) of cable was used in the installation. The maximum speed for the crane was 1.83m per minute (6ft per minute). All movements were controlled by two solenoid brakes: one a working brake and one the emergency. Arrangements for testing the crane were a major feature of the construction process. Huge steel slabs were sent from England, some weighing 20.32 tonnes (20 tons) and mounted in a cradle to obtain a good test lift. The reeving (or threading) of the wire ropes was an innovation. There were over 16.67km (9 miles) of steel wire. On the main winding drum alone there were twenty-four pulleys; twelve at the top and twelve at the bottom for lightening the load. The wire therefore had to be specially made measuring 762m (2,500 feet) in length. There were one hundred tests conducted in total, covering every function of the crane for each particular load in hoisting, slewing and radius in regard to the required specification. The crane had a hoisting speed of 3.66m (12ft) per 55 seconds at the maximum working load. When a test load of 317.5 tonnes (312.5 tons) was lifted at 36m (118ft) radius, a deflection of 12.38cm (4.7/8 in) occurred at the nose of the jib. This deflection was not permanent and the jib came back to its original position when the load was taken off. The efficiency of the braking system in regard to power failures was also stringently tested. With the maximum working load (254 tonnes), power was cut off in mid-air. Then both the working brakes in addition to the emergency brakes were also disconnected. The load was then in free fall. As this massive load was running, the brakes were re-connected and their efficiency recorded. The crane passed such rigid testing to the satisfaction of all concerned.

Description

The Hammerhead Crane consists of an asymmetric horizontal steel truss boom 83m (273ft) long, with a maximum radius of 40m (131ft), swivelling on a square section steel truss tower 15.2m (50ft) square, a height of 68 metres (179ft 3in) from wharf level to top of the cantilever. The main machinery house is situated on top of the boom, making the total height of the complete structure 61.9m (203ft) from wharf level. Foundations consist of four main concrete bases 39.3m (129ft) deep and 30.5m (100ft) below the low water level being 4.6m (15ft) in diameter, taken down to the rock bed. The maximum lift of the crane is 254 tonnes (250 tons) when the two main purchase hooks are coupled. All crane motors and swivelling gear are electrically driven. The two main purchase hooks are each powered by 90 horsepower motors (maximum 1,000-revolution variation to 100 revolutions minimum) with automatically adjusting brush gear for speed control. Combined, the provide a lift of 254 tonnes (250 tons) operated by one lever, a 40.6 tonne (40 ton) auxiliary hook powered by a 90 horse power motor is also part of the lifting capacity of the crane. A 10.16 tonne (10 ton) capacity hook for handling lifting gear and other items is also available and there is also a 6.1 tonne (6 ton) travelling crane in the main machine house used for maintenance purposes. When tested initially

after completion, the maximum test load was 317.5 tonnes (312.5 tons) lifted, lowered and controlled. Steel wire used in the mains sections totalled 1,422 tonnes (1,400 tons), apart from the 71.12 tonnes (70 tons) of electrical gear used. The top of the tower is formed by four 20.32 tonne (20 ton) main girders. Approximately 250,000 rivets were used in construction.

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