Stonecutters Bridge – Main Span Erection

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Summary

Stonecutters Bridge is a cable-stayed bridge which will span the Rambler Channel in Hong Kong above the busy shipping channel. Construction commenced in early 2004 and the bridge is scheduled to be open to traffic in mid-2009. Steel deck segments in the main span are lifted from a dynamically positioned barge using lifting frames with high capacity winches to minimise the lifting time. Stay cables are the prefabricated parallel wire type, delivered to site on large reels. The unreeling and lifting procedures ensure the bending radius of the cables is kept above the minimum allowed. Stressing to predetermined installation length is by large hydraulic jack beneath deck level. Cable forces are calculated from the frequencies, measured by accelerometers. At the end of each erection cycle, surveys of the bridge geometry are compared with the predicted deflections for that stage and any adjustments calculated. Main span closure will follow towards the end of 2008.

Keywords: cable-stayed bridge; steel deck, stay cables, erection techniques, geometry control.

Abstract

The 1596m long bridge has a twin girder steel deck of 65 segments, forming the main span of 1018m and 49.75m in each back span. The remainder of the back spans are prestressed concrete. The total deck steel weight for the dual 3-lane deck is 33,200T, due to the relatively heavy deck plate required because of the intense fatigue loading, and the overall capacity required for the high variation in live load effects caused by the turbulent typhoon wind loading.

Detailed design [1] was by Arup and Cowi. Construction commenced in April 2004 by the Maeda-Hitachi-Yokogawa-Hsin Chong JV, with Maunsell AECOM as their construction consultant. Tower and concrete back span construction, fabrication and match assembly of the steel deck units, and the Heavy Lift of the steel deck sections above land are described in detail in [2] and [3]. This paper describes the main span erection and stay cable installation, which will continue through 2008.

Main span deck segments are erected by cantilevering out from each tower. Each 18m long, 53m wide segment comprises the twin deck with connecting cross girder and weighs around 500T. One of the main project constraints is the need to maintain the flow of shipping unhindered by the construction of the bridge. Simulations of shipping movements and measurements of the currents were made. A dynamic positioning barge delivers each segment and uses GPS to accurately maintain the

Figure 1 Steel Deck Segment Lifting

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position prior to lifting. A rapid lifting speed is key, so the lifting frames at deck level are equipped with high capacity winches which can raise each segment 70m into place in around 40 minutes.

Due to the different support conditions there is a geometric mismatch between the lifted segment and the deck cantilever tip, which has considerable transverse sagging. A temporary bowstring prestress arrangement is installed on the lifted segment to manipulate the shape accordingly.

Once in place, welding to the previous segment, and installation of the stay cables follows. An 8-day target for each cycle is set, meaning that a segment is lifted on either the East or West sides every 4 working days.

Stay cables are fabricated in China and delivered to site on large diameter reels. The initial cables are unreeled vertically from ground level and the tower socket lifted directly up to the anchorage. Longer cables are unreeled horizontally at deck level with the deck socket first being pulled along the deck, and then the tower socket lifted up.

A minimum bending radius of 25 times the radius of cable is adopted during site operations to avoid damage to the cables.

Stressing takes place using a large hydraulic jack below deck level. Installation length is the governing parameter, controlled by the fabrication length and a stack of shim plates. Any adjustments required to the length can be made by adjusting the number of shims in the stack. Accelerometers are mounted on each cable to measure the frequencies of ambient vibrations from which the actual cable force can be calculated.

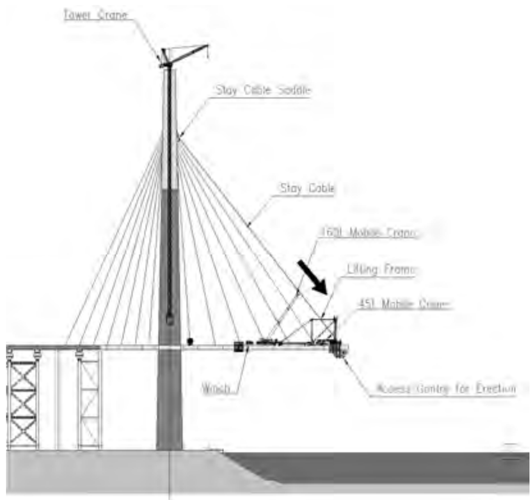

Figure 2 Stay Cable Installation

At the end of each erection cycle a detailed survey of the bridge geometry is carried out between midnight and 6am to minimise the impact of differential temperatures. The deflection of the tower and the profile of the deck is measured. The cable forces and bridge deflections (adjusted to a reference temperature) are checked against the predictions for that particular stage to ensure that the construction geometry remains on target. Decisions are made on whether any alterations are required to the stay cable installation lengths in order to remain within the specified tolerances.

Erection of the 5.3m long mid-span closure segment, cut to suit the exact as-built gap, will be by special lifting frames spanning between the tips of the cantilevers. On completion of deck erection a full survey, including stay cable load measurements, will be carried out and any adjustments to the stay cable lengths required to meet the geometry tolerances will be determined.

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References

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