Cutting-edge Technologies to Shorten Bridge Construction Time - The Rapid Launching and Jack-Down Method for the Erection of 2700 tons of Steel Girders –

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In a bridge erection project, reducing construction time is one of the most sought after aspects by both the project owner and the local residents, since it leads to early cost recovery, improved public convenience and a reduction of CO_2 emissions due to relief from traffic congestion. Mitsubishi Heavy Industries Bride & Steel Structures Engineering Co., Ltd. (MBE), a pioneer in the bridge industry, has continued to lead Japanese bridge engineering and offers innovative solutions for high quality social infrastructure construction, together with an excellent safety record.

This document describes an overview of the fast construction of a 2,700-ton steel girder as an example of such solutions, and introduces MBE's latest erection technologies for steel structures.

1. Overview of fast construction

The bridge to be explained here was built over the Arakawa River between the Kawashima Interchange and Okegawa Junction on the Ken-O Expressway, and has been in service since March 2010. This erection project attracted a lot of interest because it was expected that the bridge would relieve traffic congestion in areas around Tokyo and reduce CO_2 emissions.

According to the opening schedule of the Ken-O Expressway, this bridge was required to be built in a little less than two months. Because the standard construction time of an equivalent bridge is three months or longer, it was necessary to take the right measures to deal with such a very tight construction time requirement.

1.1 Tasks and problems

The bridge consisted of up and down lanes, and each of them weighed 1,350 tons. If the standard construction method, which includes the launching of girders one by one, jacking down the girders and dismantling the equipment, had been used, a construction time of three months or longer would have been required. To complete the task of reducing construction time from three months to two months, the following two problems with the standard construction method were discovered.

(1) Installation and replacement of equipment and control of launching amount required two months or longer.

(2) Jacking down (3 m) the launched girders required approximately one month.

1.2 MBE's solution

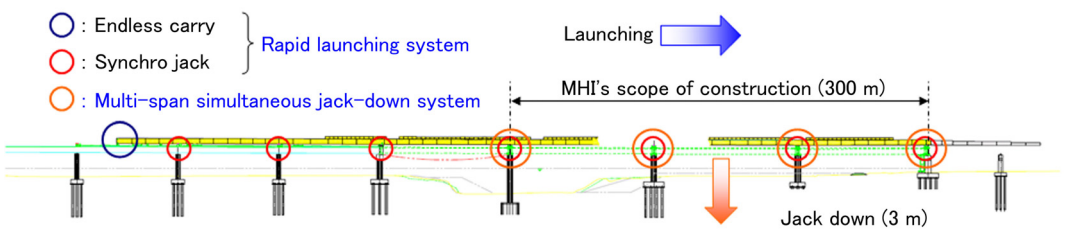
MBE took the following measures to deal with the two problems with reducing construction time (**Figure 1**) .

(1) Employment of continuous rapid launching system

(For elimination of equipment replacement and attainment of central control of launching on the control monitor)

(2) Employment of multi-span quick jack-down method

(For simultaneous jacking down of multiple spans through the use of a synchronized seamless hydraulic system for all supporting points)



[1] Endless carry (Prestressing steel wire continuous driving system)	[2] Synchro jack (Endless roller type launching system)	[3] Multi-span simultaneous jack-down system (Center hole jack)
		
Pulls the prestressing steel wire to provide propulsive force for launching – Travel speed: 750 mm/minute max. – Pulling force: 50 tf per machine – Can be synchronized with other hydraulic propulsion systems	– Ensures continuity through use of trackless sliding surface – Rotating and lateral direction following function <Actual construction performance through use of this system> 110 m/5 hours (road bridge)	Attains significant reduction of construction time due to employment of 4-span simultaneous jack-down method in comparison to jack-down method using vertical jacks with saddle replacement. (Standard method: 1 month –> This jacking system: 3 days)

Figure 1 Overview of construction methods

Both construction methods offered above were developed by MBE. In particular, the rapid launching system had many actual achievements and was a reliable method for reducing construction time. Although the quick jack-down method was used for the first time in an actual project, a significant amount of advance verification was implemented. The quick jack-down method achieved recognition of its excellent safety and construction time reducing effect. As a result, the method has been increasingly selected in subsequent projects.

1.3 Outcomes

MBE, by taking advantage of its technologies, attained a reduction of construction time, which was impossible with the standard construction method, while offering a safe and high-quality product, and therefore received a high evaluation from the parties concerned.

2. Latest erection technologies and their applicability to steel structures

This section describes MBE's latest erection technologies. Such technologies can be applied to the installation of various structures, and are expected to have an effect on not only bridges, but also structures bound by similar restrictions.

2.1 2-axis slide system (Figure 2)

The 2-axis slide system is a carrier applicable to a rotational and lateral installation method. This system can travel in two directions continuously, and therefore can continuously carry blocks constructed on a temporary stage in the yard to the installation location. This system is applicable to the transfer of steel structures for which the temporary supporting points move sequentially.

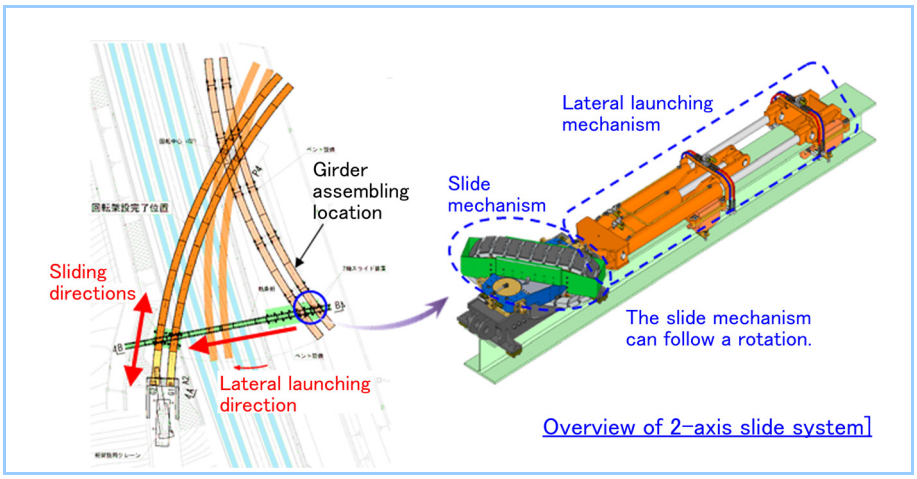


Figure 2 2-axis slide system

2.2 Telescopic lift with large lifting range (Figure 3)

This lift is temporary telescopic equipment (a bent) that can extend and retract by approximately 3 m. In the erection of a bridge, this lift is used for construction in narrow areas where a large crane cannot be used. The uppermost part is constructed first. It is then lifted up and the lower parts are constructed sequentially. This lift can be used not only when the yard is restricted, but also when the crane boom cannot extend sufficiently due to the existence of a ceiling.

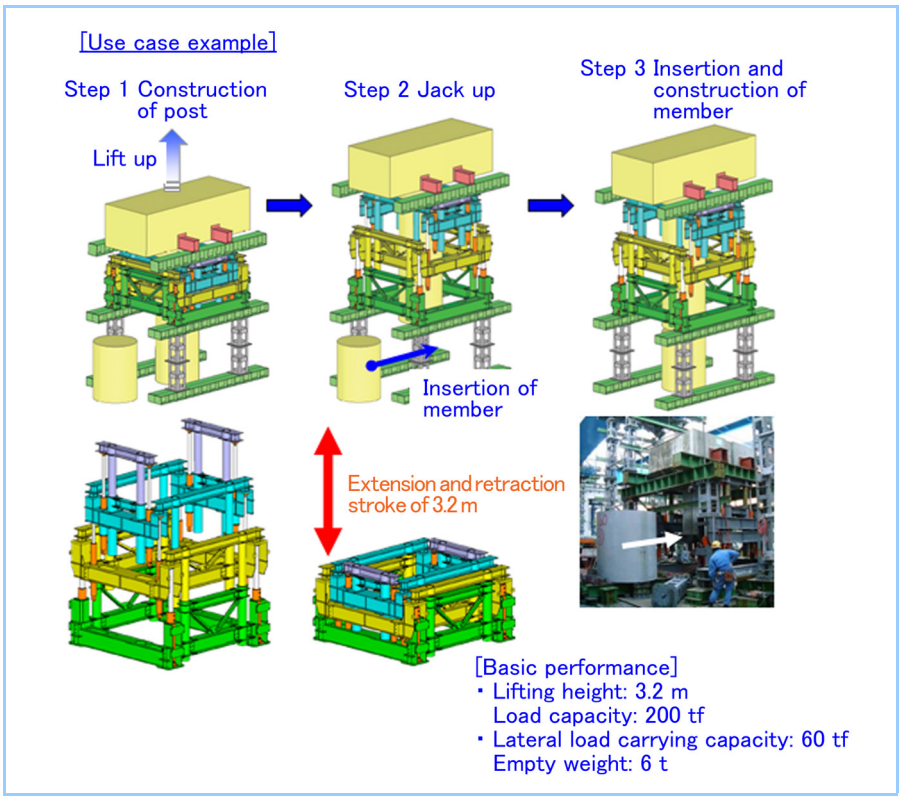


Figure 3 Telescopic lift with large lifting range

2.3 Quick installation of temporary bents due to automatic height adjustment system (Figure 4)

This system measures the height of a temporary bent at its four corners using a laser sensor, and then adjusts the setting height to horizontalize the measured points using fully-automatic hydraulic screw cylinders. When a temporary bent is installed on a place where the restriction period is limited, such as an in-service road, this system can reduce the installation time significantly.

2.4 Developing construction method through use of parasol jack (Figure 5)

A parasol jack has a special structure using the principle of an umbrella. In the erection of a bridge, this jack is used for the unfolding of the steel plate deck. This jack can unfold a member without a crane, and therefore enables construction in narrow spaces. As a result, restrictions on yards or crane installation sites can be eliminated.

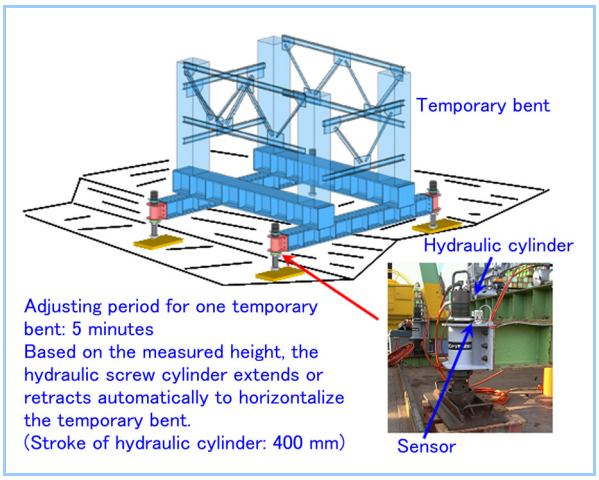


Figure 4 Automatic height adjustment system for temporary bent

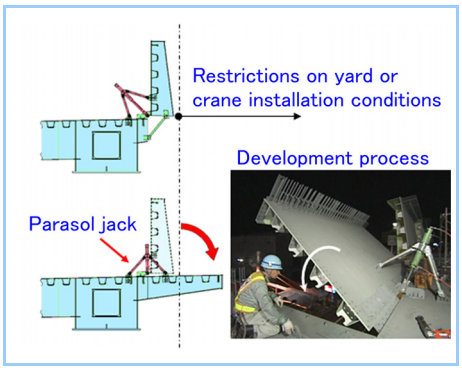


Figure 5 Parasol jack

2.5 Universal crane (Figure 6)

The universal crane is a small crane that runs on a railway track. This crane can be used regardless of track gauge, because its frame shape can be changed depending on the gauge.

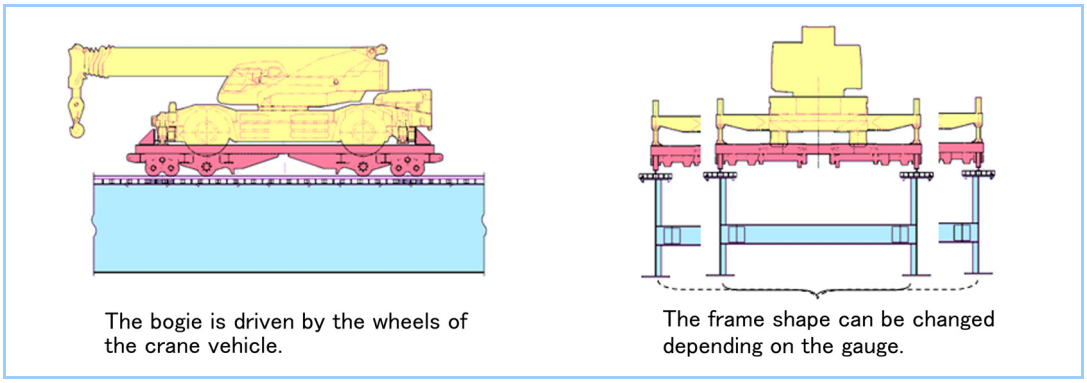


Figure 6 Universal crane