Newly Developed Bridge High-performance Steel and its Application to Tokyo Gate Bridge

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Summary

This paper describes the proposed properties of "SBHS" (Steel for Bridge High-performance Structures) based on the required performance for bridges and the advantages of SBHS in design and fabrication of steel bridges. New structural designs of all welded superstructure became possible by using SBHS, also resulting in the creation of esthetic values for Tokyo Gate Bridge. Through the large scale application of SBHS to the Tokyo Gate Bridge project, the advantages have been confirmed, such as cost saving of construction, reduced weight of superstructures. The SBHS is expected to contribute to the more economical and higher quality of steel bridges in the future

Keywords: steel bridge; long span bridge; fatigue; fracture toughness; high strength; weld

1. Introduction

New Bridge High-performance Steel was developed and applied to Tokyo Gate Bridge, the total length of 2 618 m, in which the main bridge is a box truss hybrid girder with the length of 760 m, the main span of 440 m as shown in Fig.1, opened to traffic in 2012. This new steel is specified as "SBHS" and included in Japan Industrial Standard (JIS) in 2008. It has been 40 years since the last establishment of standard as a steel plate grade for bridges. The new specification SBHS contributes to the economical design, efficient fabrication and higher performance of steel bridges.

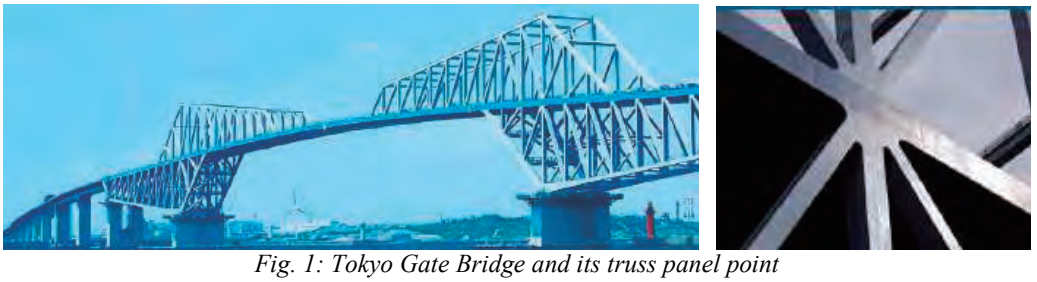


Fig. 1: Tokyo Gate Bridge and its truss panel point

2. Features and New Technologies for Tokyo Gate Bridge

The construction of the Tokyo Gate Bridge was undertaken with many restrictions. The structural type and construction method was determined considering the disturbance of navigation to the minimum. As a result, the structural shape was initially determined to be a cantilever truss. The continuous truss box hybrid girder was finally proposed. All welded compact truss panel points

were designed (Fig.2). Field welds were widely used for the joints of main members (Fig.3). Each truss block with the weight of 7 000 ton was erected using three floating cranes simultaneously.

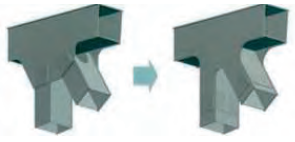


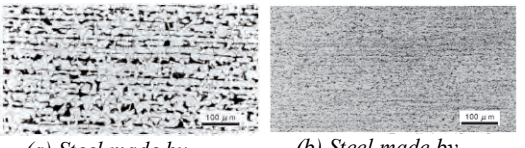
Fig. 2: All welded compact truss panel point in comparison with conventional one

Fig.3: Field weld of truss main members on site (fabrication yard)

Fig.4: A truss block erection using three floating cranes simultaneously

3. Newly developed "Steel for Bridge High-performance Structures (SBHS)"

The performance of SBHS is created based on the Japanese advanced steel making technology that is called as Thermo Mechanical Controlled Rolling Process (TMCP). The microstructure of TMCP steel is quite obviously different from those of steels produced in the past.



(a) Steel made by Continuous Casting and Rolling(1994)

(b) Steel made by TMCP (2009)

Fig.5: Historical change in microstructures

4. Application of SBHS to Tokyo Gate Bridge

Using high strength of SBHS, effective design of member sections is possible, which results in steel weight savings. In the case of Tokyo Gate Bridge, Ministry of Land, Infrastructure &Transport reported 3 % of steel weight saving and 12% of total cost saving including the effects of improved efficiency of welding and reduction of total weight of erection. The fabrication of the truss panel points is carried out using SBHS with the good weldability by completely eliminating pre-heating process and accordingly, offers better quality of welded joints.

5. Conclusion, for the future of steel bridges

The application of SBHS is gradually increasing. Finally, the competitive design code for the effective use of high performance steel is desired. The high performance steel is expected to contribute to high quality, durable, safe and economical world steel bridges in the future.

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