Research on the application of super high tension bolts to highway bridges

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1. Introduction

Connecting members to erect a steel bridge is usually done by welding, or using high strength bolted friction joints (Photo 1). The higher the strength of the bolts used, the smaller the joints and the less work required to construct the connections, contributing to the reduction of costs of construction, repair, and retrofitting of highway bridges. Although bolts (F13T, F11T) stronger than the usual bolts (S10T, F10T) since 1964 were adopted, the phenomenon—brittle failure (delayed failure) suddenly occurred in F13T, then later the same damage occurred in F11T beginning in 1975, so its adoption was stopped from the 1980 design standards. Since 1991, under an administration circular from the Road Bureau of the former Ministry of Construction, bolts in danger of delayed failure have sequentially been replaced fall prevention measures have been taken. As this shows, there was concern about the long-term durability of higher strength bolts, so since then, no research on the applicability of higher strength bolts to steel highway bridges was carried out. But in recent years, super high tension bolts (S14T) created by improving delayed failure resistance performance were developed, and they have been adopted in the building construction field. Now the NILIM is studying the application of super high tension bolts (S14T) to highway bridges.

When applying these to highway bridges, because the harshness of the environment when used mainly outdoors (influence on delayed failure in particular), execution methods, number of rows of bolts etc. differ from those in the building construction field, joint research by industry, academia, and the government is being carried out to set required standards for quality of long-term durability and execution methods, including delayed failure. The NILIM is performing standard slip tests (Fig. 1), bending tests of connections of a girder (Fig. 2), and numerical analyses.

2. Past results

Durability is tested by measuring the hydrogen content of bolt materials, which is a factor related to delayed failure, accelerated corrosion testing (photo 2) and surveys of corrosion of high strength bolts in existing bridges.

Regarding execution methods, precautions to be followed in design and execution, which can ensure quality, are organized.

Standard slip tests were done within a range where high strength bolted friction joints have been used in existing bridges, and with connection surface treatment, base material plate thickness, base material quality, hole diameter, number of rows of bolts, and reassembly etc. as parameters, obtaining a slip coefficient of 0.45 or higher used to evaluate slip strength of high strength bolted friction joints stipulated by the present design standards, except in cases where organic zinc rich paint is used as to coat the surface. The girder bending test performed under different main girder flange thickness and bolt layout conditions, similarly, obtained a slip coefficient value equal or higher than the stipulated 0.45, too.

3. Future challenges

Based on past results, test data and numerical analyses results will be completed and testing done to reflect these in design and execution standards.

Photo 1. Example of a steel bridge high strength bolted friction joint

Photo 2. Accelerated corrosion test

Figure 1. Standard Slip Test

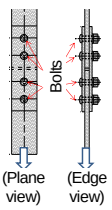
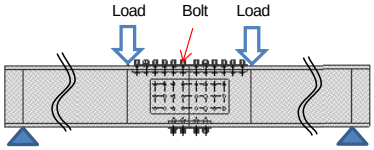


Figure 2 Girder Bending Test



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