

Suspension bridge cable clamp installation: Bolts of Bosphorus Bridge were tightened precisely with ITH Bolting Technology

During a main overhaul project the bolted joints of the cable clamps were bolted simultaneously – Successful project management between Turkey, Japan and Germany

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Istanbul, Turkey | Tokyo, Japan | Meschede, Germany

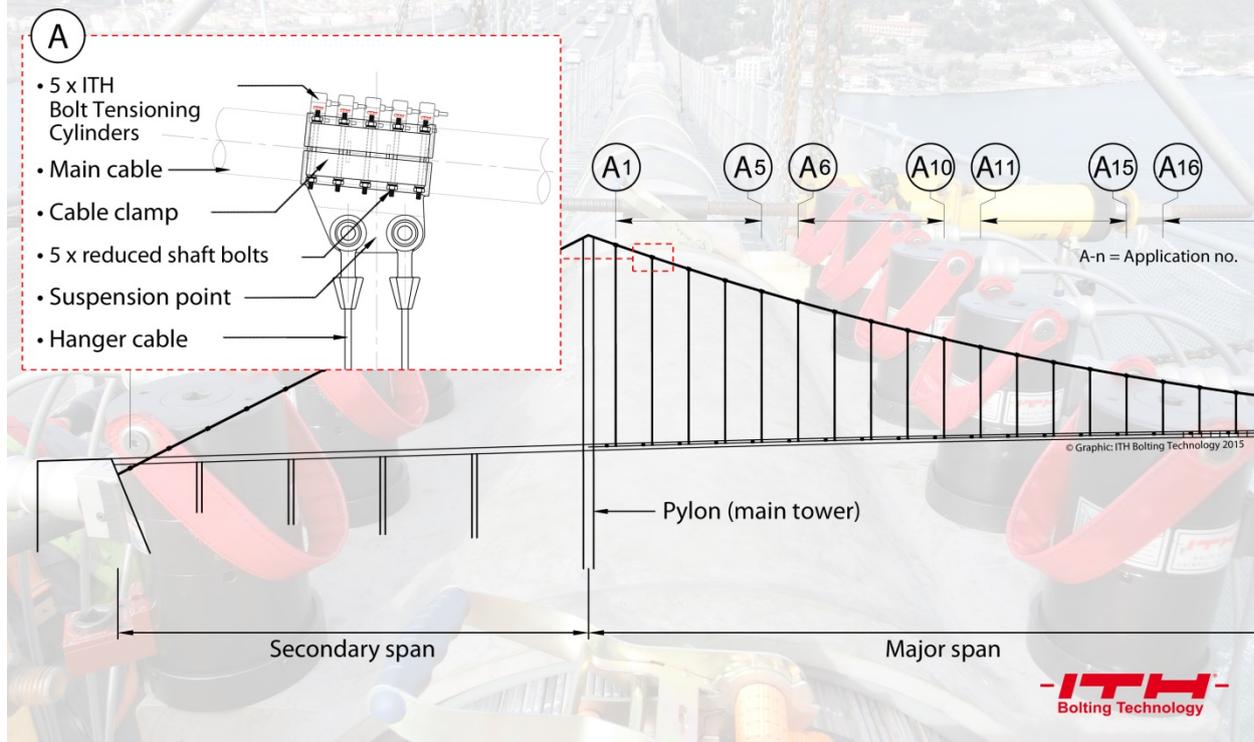
There are currently only two highway bridges spanned over the Bosphorus in Istanbul, which are hung by two main cables a with total length of 1,400 Meters (4,593 ft.) and diameters of more than 2.5 Meters (8.2 ft.) each. These main cables consist of numerous, smaller and high-strength steel wires which are pressed together by 84 concrete cable clamps. During a main overhaul project nearly 700 reduced shank bolts M36 x 734 (d 1 3/8` x l 28.9`) of all 84 cable clamps were tightened precisely and reliably. ITH Bolting Technology provided bolting tools, engineering know-how, professional project management and fulfilled all requirements of this international large-scale project.



The bolts of the concrete cable clamps on the Bosphorus Bridge in Istanbul, Turkey were tightened precisely with 10 x ITH Bolt Tensioning Cylinders type ES 36-470. The bridge connects the European continent with the Asian continent.

Picture: ITH Bolting Technology2015

Cable clamps in bridge construction: precise bolt tightening



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1. Tightening cable clamp bolts precisely with ITH Bolt Tensioning Cylinders

To carry the various loads (self-weight, working load, dynamic loads) efficiently, main cables of suspension bridges are often made out of numerous single steel wires. This concept is also used at the Golden Gate Bridge in San Francisco, USA for example. These high-strength wires are anchored in concrete foundations on both sides of the coast (anchor blocks). While extended over the two main towers (pylons) of the bridge, the wires are pressed together and by large concrete cable clamps. The Bosphorus bridges use two designs of cable clamps:

- Cable clamp, two-sided, inner diameter $r > 280 \text{ mm}$ (11''), 10 x reduced shank bolts M36x734 ($d \ 1 \ 3/8'' \times l \ 28.9''$) with cardanic washers
- Cable clamp, two-sided, inner diameter $r > 290 \text{ mm}$ (11.42''), 4 x reduced shank bolts M36x734 ($d \ 1 \ 3/8'' \times l \ 28.9''$) with cardanic washers

Those cable clamps, which are positioned between two main towers (pylons), also provide a suspension point for the series of vertical hanger cables, which carry the deck. At the suspension point the cables are seated in a spherical bearing while anchoring in a cast iron plate when fixed to the traffic-carrying deck.



5 ITH Bolt Tensioning Cylinders per side are temporarily mounted to the top of the bolts and tighten the bolted joint of the cable clamp $r > 280 \text{ mm}$ (11'). The required preload force is applied simultaneously and with a high precision of $\pm 2.0\%$.

© picture: ITH Bolting Technology 2015

1.1. Using cardanic washers when bolting cable clamps

Compared to steel parts in machine engineering the production tolerances in steel construction and the tolerances of the concrete-composite cable clamps are relatively high. The supporting surfaces were not machine processed. This and parameters of the design of the clamps lead to a certain vertical misalignment of the reduced shank bolts. This effect was compensated by the use of cardanic washers, which were included between the nuts and the supporting surface.

Accordingly the ITH Bolt Tensioning Cylinders were designed with integrated cardanic washers as well. „By this customized design we ensure that the required preload forces are applied evenly and with a high precision“, explains Frank Hohmann, general manager of ITH Bolting Technology. „This is integral for the long-term stability of the bolted joint“.

1.2. Precise implementation of the pre-load forces by ITH Multi Tensioning

Before the bolt tightening of the cable clamps the main cable was pressed together by a hydraulic press. After that all bolted joints were tightened simultaneously by using the „ITH Multi Tensioning“ method.

Therefore ten – respectively four, depending on the application – ITH Bolt Tensioning Cylinders type ES 36-470 were connected to one hydraulic circuit and then connected to the ITH hydraulic pump.

This ensures the pre-load forces are transferred into the bolted connection with a tight tolerance and high precision of $\pm 2.0\%$.



ITH Multi Tensioning: Simultaneous bolt tightening of 4 x reduced shaft bolts with ITH Bolt Tensioning Cylinders type ES 36-470.

© Picture: ITH Bolting Technology

2. International industry leaders trust in ITH Bolting Technology

„Infrastructure projects of this size create a certain public attention, because it affects the people’s lives“, Frank Hohmann says. „Obviously no project partner could afford any time delays. We are happy that all sides were satisfied with project management and bolting job performance by ITH“.

For this main overhaul project of the Bosphorus Bridges the Turkish Ministry of Traffic contracted a Japanese construction company, which chose ITH Bolting Technology for their expertise in bolted joints. Next to on-time project management there were two more decisive factors for the Japanese company:

- a. Extensive technical capabilities of bolting tools and bolted joints
- b. Working safely according to international work safety standards

„International projects are our daily business. It was beneficial to include our team from ITH Japan into the project“, Frank Hohmann explains, who leads the family-run and international acting company ITH Bolting Technology together with his brother Joerg. „We are thankful for the trust our customer has set in us and happy that we have met all expectations“.

And this was not the first time: ITH Bolting Technology maintains long-term relationships to worldwide industry leaders, which trust in the know-how and the experience of ITH Bolting Technology. Among other industry sectors ITH bolting tools are used in all power generating industries like wind turbines, construction and mining

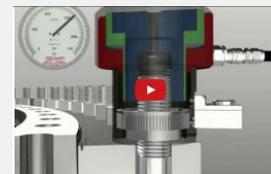
machines, oil & gas, offshore industries, general engineering companies and more. ITH bolting tools have also been used at the Oresund Bridge between Denmark and Sweden and Kattwyk Bridge in the harbor of Hamburg, Germany.

3. 1,400-Meter-main-cables span the 1,000-Meter Bosphorus strait / Loads of 400,000 cars per day

The only two Istanbul car-highway bridges over the Bosphorus strait – the „Bogazi Bridge“ (identification 1 BB) and the „Fatih Sultan Mehmet Bridge“ („FSM“, 2 BB) – are loaded with more than 400,000 cars per day. The two main towers (pylons) of each bridge have a total height of 165 Meters (541 ft.) and stand in a distance of 1,074 Meters (1 BB; 3,523 ft.) – respectively 1,090 Meters (2 BB; 3,576 ft.) – on the European continental side and the Asian continental side in Istanbul, Turkey. The bridges have six-lane traffic-carrying decks which are held by main cables with a total length of 1,400 Meters.

Facts & Figures: Bolt tightening of the Bosphorus Bridges

Place:	1) Bogazi Bridge (1 BB), Istanbul, Turkey 2) Fatih Sultan Mehmet Bridge (2 BB), Istanbul, Turkey
Application:	2 x concrete cable clamps, inner radius: $r > 280 \text{ mm}$ (11''), respectively $r > 290 \text{ mm}$ (11.42'')
Bolt connection:	Reduced shaft bolts M36x734 (d 1 3/8'' x l 28,9''); projecting thread $> 70 \text{ mm}$ on both ends, cardanic washers.
Bolting tool:	Single-staged ITH Bolt Tensioning Cylinders type ES 36-470, patented ITH safety concept, spring-loaded turning sleeve, cardanic washer integrated at the support.
Tightening method:	„Hydraulic friction-free and torsion-free tensioning“ by „ITH Multi Tensioning“: Simultaneous bolt tightening of two or more bolted joints ensures a high precision of $\pm 2.0\%$ when applying the preload forces. Therefore the Bolt Tensioning Cylinders are connected together to one hydraulic circuit. Then they are pressured by the ITH hydraulic pump ITH Eco-MAX 17.
Further information:	„Hydraulic friction-free and torsion-free tensioning“: <ul style="list-style-type: none">• The 3D-Animation video explains the method in 49 seconds and can be found on www.ITH.com.• Tensioning tools & Torqueing tools for bridges http://www.ith.com/industries/tension-and-torque-tools-for-steel-constructions.php



Media Contact
Mr. Sebastian Jütte M.A.
Head of Marketing
ITH Bolting Technology

ITH GmbH & Co. KG
Auf'm Brinke 18
59872 Meschede
Germany

Tel: +49 (0) 291 - 99 62 - 0
E-Mail: sjuette@ith.de
Website: www.ITH.de