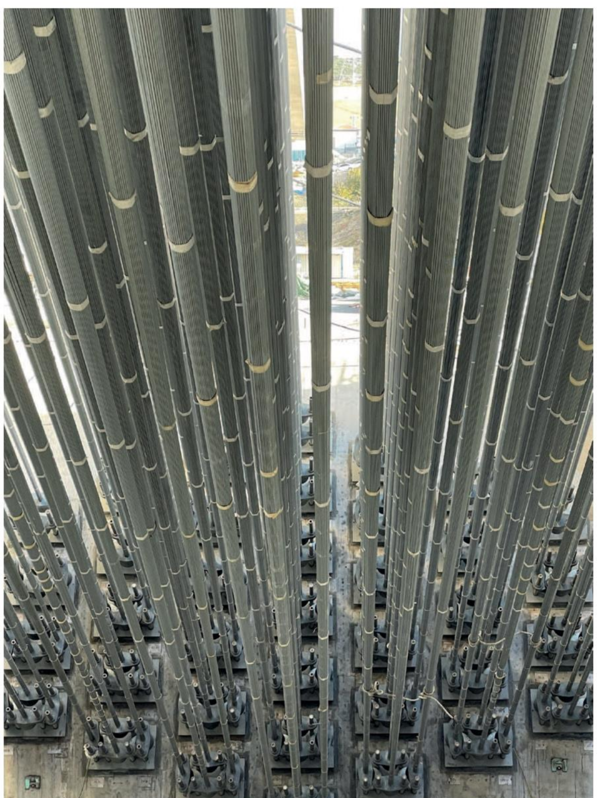
The main cables are protected from the elements with a 1.1mm-thick elastomeric wrap

IT'S A WRAP

With cable-wrapping of the newly opened Çanakkale Bridge's reaching its final stages, *Bd&e* finds out more details about the innovative corrosion protection system planned for the record-breaking structure in Turkey



The four anchor and splay chambers will also be dehumidified

The technology that is currently being installed on the 1915 Çanakkale Bridge marks a new stage in the development of dehumidification systems on long-span bridges by recirculating the dry air from girder to the main cables and back again, saving energy consumption..

For the 120-year design life of the Çanakkale Bridge to be reached each of its steel elements has to be protected from the highly corrosive environment of the Dardanelles. For the cables, this is achieved with a wire wrap and F outer layer in combination with dehumidification technology installed on the main girder, while separate dehumidification systems protect the two steel towers and four anchor chambers.

At the time of writing (March), cable wrapping operations were under way on the 876mm-diameter and 888mm-diameter main cables on the Çanakkale Bridge's main span and side spans, respectively. When completed, a dehumidification system will be installed that will circulate dry air with humidity below 40%, eliminating the risk of corrosion. A total of 14 dehumidifiers will be installed, one for each of the four anchor and splay chambers, one in each of the two towers, and four in the girder.

Dry air from the girder will be circulated in and out of the main cables via 11 injection sleeves and 12 exhaust ports, spaced typically every 200m, or every seven hangers. The dry air will be pumped at a maximum 2,500Pa (55m³/h) into the cables, a level of pressure designed to protect the wrapping against eventual bulging, and one that will be monitored and controlled by sensors at the inlets and outlets.

Such systems have in the past been used to dehumidify a particular section of a bridge, such as the cables or the girder, with all dry air vented outwards. But on the Çanakkale Bridge, the integrated system will push dry air from the girder up into the cables, and back again, in a circular fashion. "The exhaustion points are connected by a hose to the girder. Used air that is still dry is therefore led back into the bridge girder, creating a closed environment where you only need to dehumidify the air you lose due to leakages, which is approximately 20%," explains Jesper Pihl, cable structures specialist and deputy project manager, COWI.

There is some precedence for similar systems on bridges around the world. An integrated system is used on the Hardanger Bridge in Norway, where the two dehumidification plants in the box girder protect the inner surface of the box girder and use the volume as a buffer chamber for provision of dry air to the main cables. There, ducts run up through the towers to injection points at the saddles and along two of the shorter suspender cables to injection points on the main cables. In this manner, one integrated dehumidification system protects the box girder and the main cables. "The approach from Hardanger was further developed on Çanakkale Bridge, but actually, the Hålogaland bridge – opened in 2018 – is closer in design to Çanakkale," says Pihl. "There, the dry air from the box girder is still led into the main cables, but as opposed to Hardanger it is not exhausted into free air but taken back into the box girder by use of hoses similar to the injection points. On the Çanakkale Bridge, however, the tower saddles are not used as injection points but as exhaust points," says Pihl. The reuse of dry air is expected to save energy once the cable is relatively dry. "If the cable wrapping is tight, then you just keep the dry air flowing with the minimum amount of power. You don't need all that additional energy to dry the air," explains Pihl.

Sensors at the exhaust points will measure variations in pressure loss and humidity between the inlets and outlets, which means any pressure losses can be quickly noted and the approximate location of a failed air-tight seal (for example) identified, "Whereupon the old-fashioned soap-and-water method can be used to located the exact location of the leak," says Pihl. Aware that the area most likely to suffer a possible pressure failure is at the cable clamps, COWI worked on improving the traditional cable clamp bolt design to find a better solution for the bridge. "The issue is that air will penetrate the threads of the bolts and therefore we see pressure loss at the clamps, even though the gap between the two clamp parts is sealed. So on the Çanakkale Bridge we designed an O-ring and a bolt cap on top of the bolts, so the cable clamp could be sealed very tightly," says Pihl.

The 1915 Çanakkale Bridge's main cables are currently at around 50% of completion of wire and Cableguard wrapping. The wire wrapping is carried out with a 10m-long wrapping machine in a slow and laborious operation where it can take up to a day to complete a section from cable clamp to cable clamp. Immediately behind the wire-wrapper is the equipment required to install the 1.1mm-thick Cableguard elastomeric wrap. This is applied with a 50% overlap to ensure a complete seal using a special wrapping machine. The operation is then completed by heat-bonding the elastomeric layers, which slightly shrinks the material to a tight fit around the cable.

Until the wrapping is completed, the main cables will remain open to the elements and indeed they are expected to be fully soaked after months of construction in the unpredictable marine environment of the Dardanelles. Steve Mathey, international Cableguard sales manager at DS Brown – a company which has wrapped the cables of over 25 dehumidified bridges – explains that for smaller dehumidified cables, it can take around six months for a newly installed cable to dry out after installation. "During that time, the dehumidified air is slowly flowing through the cable, picking up the moisture from the cable and, for a span as long as the Çanakkale Bridge, this could take nine months to a year," he says. "On the Hålogaland Bridge, 300km north of the arctic circle, the water [on the cable] was frozen so it took longer," adds Pihl.

Once the dehumidifying system is operational, it will be possible to calculate the amount of water removed from the cables by measuring the relative humidity of exhausted air. "I've seen some statistics on bridges where 1,000 litres of water have been removed during the drying period, which does not add a lot of weight to the bridge," says Mathey. It is an additional weight that does not concern COWI, "We don't calculate the weight of the water on the cable but we have a safety factor of approximately 2.2 so adding a few kilograms of water is of no concern. Any water that is present will go down to the bottom of the cables and be trapped. We have around 18-19% air inside the compacted main cable, so it is kind of easy to calculate the weight per metre."

Once the main cables have been wrapped and the dehumidification system is fully operational, says Mathey, the wrapped cables will require little maintenance above visual inspections every five years. "We are looking for damage to the wrap, which typically happens at roadway level where trash gets thrown on the cable and sometimes causes damage. One of the things that can be checked is the bond at the edges, where typically if bonded well when installed is already one piece."

Highlighting the reliability of dehumidification for bridges, Mathey points at the recent inspection of the cables of the Little Belt Suspension Bridge in Middelfart, Denmark. When completed in 1970, the Little Belt Bridge was the first outside Japan to include a dehumidification system in the box girder and anchor chambers. In 2003, it was retrofitted with a dehumidification system in the cables too. "The wrap is in excellent shape after over 20 years. I entered the sealed anchor chamber and not only did the cables look brand new, but there was dust. In contrast, I've been to anchorage boxes where you open up this rusty door and you can hear water dripping, and you look down and there is two feet of water and everything is rusting. It's a huge difference."

Also dehumidified are the Çanakkale Bridge's steel towers, as well as the post-tensioning cable from the splay chamber to the anchorage chamber. "It is the weakest link," says Pihl, "If you have a very wet anchorage chamber, that would be disastrous. We've seen examples in bridges where the anchor plates, which have been anchored and grouted, have actually broken. But here we will have fully protected cable strands" ■

Update (*May*): Cable wrapping has been completed and the dehumidification plant and pipe fittings are inside the deck. Currently under way is the installation of the injection sleeve hoses and, by June this year, the electrical equipment for the dehumidification plants is expected to be in place.

Cable wrapping of a section is completed by heat-bonding the elastomeric layers

CABLEGUARD™ ELASTOMERIC WRAP

for **Cable Dehumidification Systems**

Cableguard is part of the dehumidification system on 1915 Canakkale Bridge.

Cableguard protects suspension and cable-stayed bridge cables from corrosion and reduces future maintenance costs. The Cableguard wrap system outperforms paint and is ideal for use with cable dehumidification systems. D.S. Brown's easily installed and environmentally safe wrap encapsulates new and existing cables without requiring surface preparation.

D.S. Brown Corrosion Protection Installed on World's Longest Suspension Bridge

Cableguard Elastomeric Wrap is an integral part of the dehumidification system on Turkey's new 1915 Canakkale Bridge. D.S. Brown's protective wrap encapsulates this landmark span's main cables, allowing dehumidified air to be injected. This field proven system eliminates the possibility of corrosion by keeping the wrapped cables on the world's longest suspension bridge moisture free and watertight.

D.S. BROWN®
A GIBRALTAR INDUSTRIES COMPANY

The Gold Standard for Bridge Cable Protection.

dsbrown.com