Queensferry falling ice hazard solution - electrically-heated cable stays

From: Peter Dow (peterdow@talk21.com)

To: OCCR.FBScotland@amey.co.uk; info@transport.gov.scot; highways@arup.com; bridges@arup.com; alastair.dalton@jpress.co.uk

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PRESS RELEASE from Peter Dow

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Queensferry falling ice hazard solution - **electrically-heated cable stays**

Install a power supply and connect it up so that it can pass an electrical current through the cables to heat them up, and switch it on whenever they need to deice the cables.

> *"Trace heating takes the form of an electrical heating element run in physical contact along the length of a pipe. The pipe is usually covered with thermal insulation to retain heat losses from the pipe. "*
> https://en.wikipedia.org/wiki/Trace_heating

There is no need to add a "electrical heating element" in this case because the steel cables themselves can act as the conductive and resistive heating element.

Neither is there any need to add any thermal insulation. The purpose here would not be to maintain the cables above freezing temperature all the time but just to allow on command the cables to be heated up enough temporarily to melt the ice to detach concerning amounts of ice from the cables which had accumulated.

It goes without saying that **there must be an exceedingly good electrical connection where the bridge support cables are attached to the power supply cables**.

It would utterly unforgivable to have a poor high-resistance electrical connection at that critical point because the high currents could act like a welding power supply and cause severe heat damage to the steel cable at any poor connections, totally ruining the bridge support cable, which would just be very, very expensive to fix.

Initial calculations

The Queensferry crossing has in total 288 stays with each individual cable stay comprising of between 45 and 109, 7 wire, 15.7mm diameter strands. These stay cables range in length from 94m to 420m.

A 7-wire 15.7 mm diameter strand has an effective cross section of 150 mm2, which is the same as a round wire of diameter 13.8mm.

The resisitivity of high carbon steel wire is about 0.17 micro-Ohm-metres.

The DC resistance of a round wire of diameter 13.8mm and resistivity 0.17 micro-Ohm-metres is 0.001137 ohms per metre and that will be the resistance of a cable strand too.

Power heat dissipated by a resistor is current-squared times resistance, as we say, "I-squared-R".

The current required to dissipate power in resistor of 0.001137 ohm per metre is

1 Watt per metre - 29.6 amps
10 Watts per metre - 93.8 amps
100 Watts per metre - 296 amps

The voltage required can be calculated from V=IR.

For 100 metres of a single strand, the resistance is 100 x 0.001137 ohms = 0.1137 ohms and the voltages required are

1 Watt per metre - 29.6 amps - 3.3 Volts - total power 100 Watts
10 Watts per metre - 93.8 amps - 11 Volts - total power 1 kW
100 Watts per metre - 296 amps - 33 Volts - total power 10 kW

The voltage required is proportional to the length of the strand.

Although the strands are sheathed, one must ask if it is reasonable to assume that the cable strands are all insulated from each other? They could easily not be insulated where the sheathing has been crushed to nothing at certain points.

Therefore rather than assuming that one can heat only 1 strand one may have to assume that one has to heat all strands in a cable stay, which gives rather a different calculation.

Consider the case of a cable stay of 100 strands all carrying the heating current then the resistance per metre of 100 0.001137 ohm resistors in parallel is 0.00001137 ohms.

The current required to dissipate power in resistor of 0.00001137 ohm per metre is

1 Watt per metre - 296 amps
10 Watts per metre - 938 amps
100 Watts per metre - 2960 amps

For 100 metres of 100-strand cable stay, the resistance is 100 x 0.00001137 ohms = 0.001137 ohms and the voltages required are -

1 Watt per metre - 296 amps - 0.33 Volts - total power 100 Watts
10 Watts per metre - 938 amps - 1.1 Volts - total power 1 kW
100 Watts per metre - 2960 amps - 3.3 Volts - total power 10 kW

So as one can see the calculations give very different voltage and current requirements for the power supply depending on how many strands are assumed to be carrying the heating current.

Peter Dow

Science and Politics

Aberdeen
Peter Dow's website - SCOT.TK - peterdow@talk21.com - Tel. 01224 583908

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