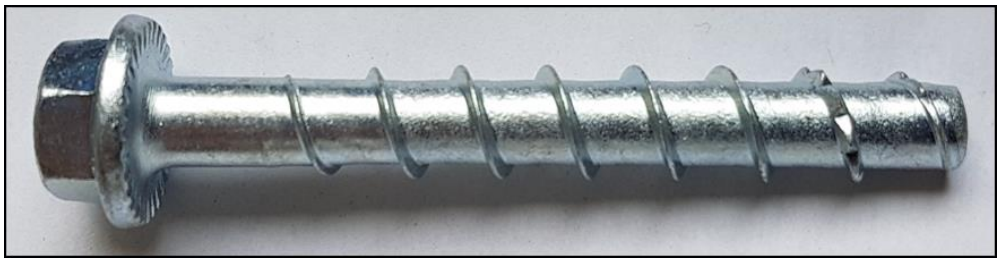
Self-tapping concrete screws: their selection, testing and use.
By Simon Wilson.



Fischer Ultracut FBS II 8 mm x 70 mm concrete screw.

What is a self-tapping concrete screw and why use them?
A self-tapping concrete screw is a screw made of zinc plated hardened carbon steel or stainless steel which has a thread and screws directly into a drilled hole in concrete or rock. By definition they are screws and not bolts.

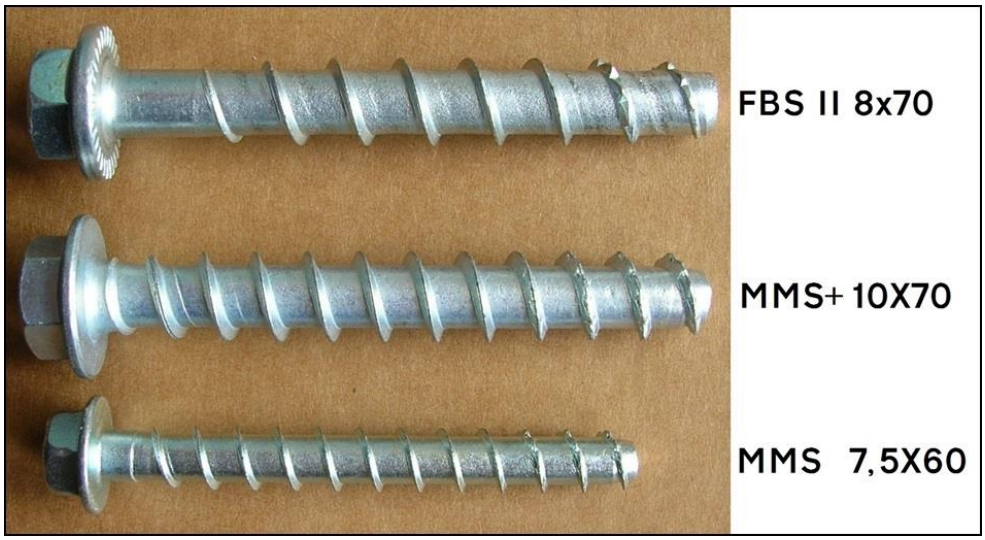
After removal of a concrete screw the hole can be used for installing a resin anchor. My interest in them at present is for trying out positions for resin anchors and for use to get into position for installing resin anchors.

Self tapping concrete screws are of benefit as temporary anchors for use in caving. They are easy and quick to install and can be loaded immediately which means they are of benefit for use during rescues and have many potential uses during exploration. The main benefit is that they can easily be removed. This means that they are far preferable from a conservation viewpoint than other types of anchor which can be difficult to remove or impossible to remove without doing a lot of damage to the rock.

Aims and objectives.
The aim of this work is to encourage the use of self-tapping concrete screws in preference to other types of anchors. The objectives are to identify the various types available, to investigate and evaluate them, to carry out testing and to provide information to help cavers choose which screws to use, to have confidence in them and the knowledge to use them safely.

What types of concrete screws are available and are they suitable for our purpose?
A number of types of concrete screw that are available in the UK were identified and investigated. Only screws which carry a European Technical Assessment (ETA) were considered suitable. It is a condition of the ETA that the screws have to be manufactured at the plant named in the ETA. This information is given as an appendix.

Of the screws which carry an ETA two brands were chosen for testing which were readily available in the UK. The particular Fischer product chosen to test was the Fischer Ultracut FBS II 8-70 which screws into an 8 mm diameter hole and is 70 mm in length. The Heco products chosen were the Multi-Monti-plus MMS-plus SS 10,0 x 70 and the Multi-Monti MMS-SS 7,5 x 60.



The zinc plated version was deemed more suitable than the stainless version because of its higher strength and lower cost. Higher corrosion resistance was not considered necessary for short term placements.

Fischer's installation guidance recommends that dust is cleaned from horizontal holes by blowing, dust need not be blown from vertical upwards holes and that with vertical downwards holes allowance should be made by increasing the depth of the holes by three times the drill diameter.

More information can be seen on the Fischer website http://www.fischer.co.uk
Under "Product range" choose "high performance steel anchors" then "concrete screws"
For Heco Multi-Monti go to:
http://www.heco-schrauben.com/screws-accessories/screws/multi-monti/
Detailed technical information is contained in the ETAs which can be found by searching the internet for the following ETA numbers:
Fischer ETA-15/0352
Heco ETA-15/0784

The screw heads are marked with the anchor type, the diameter and length. The diameter of the Fischer is designated with the drill diameter (8) whereas the Multi-Monti is designated with the outside diameter (10). Both use an 8 mm drill. The Multi-Monti 7,5 uses a 6 mm drill.

The FBS II 8x70 can be screwed in using a 13 mm spanner or TX40 torx key. The MMS 10x70 uses a 13 mm spanner and the MMS 7,5x60 a 10 mm spanner.

Both the Fischer Ultracut FBS II and the Heco MMS plus SS have a hexagon head and an integrated washer. SS does not denote stainless steel; it denotes the type of head.

Testing.

The testing was done in Great Scar Limestone on private land with permission. A purpose-made test puller was used incorporating a Richmond load cell. A special connector was made which enabled force to be applied directly in line with the axis of the screw.

Six each of the three types of screw were loaded until they failed and the peak load recorded. Only axial load tests were carried out. No radial (shear) tests were done.

All the screws broke at the point, around the start of the thread, where the shank tapers down to the core diameter. The Multi-Montis broke close to the rock surface. The Fischer screws have a plain section of shank before the thread starts which has a diameter slightly greater than the core diameter and they broke just below the rock surface.

Table of results.

Figures in kilonewtons.

	FBS 8x70	MMS 10x70	MMS 7,7x60
Max	55.03	42.56	24.58
	52.52	42.47	24.55
	51.06	42.17	24.42
	50.03	42.13	24.36
	49.56	42.00	24.34
Min	48.44	41.96	24.12
Mean	**51.12**	**42.21**	**24.39**

Fischer state the nominal core diameter of the FBS II 8-70 to be 7,4 mm and the outside diameter of the thread to be 10,3 mm. Heco state the outside diameter of the MMS+ 10,0 x 70 to be 10,5 mm and the core diameter to be 7,3 mm. Measurement showed the core diameter of the Fischer to be 7,55 and the Multi-Monti 7,35. The larger core diameter and the plain section of the shank below the head will both contribute to the higher loads for the Fischer.

One screw was tested after being screwed in and out of the same hole and one screw was tested after the same screw was screwed into a new hole. In both cases the peak load was within the range shown in the table above.

Using concrete screws.

The MMS 7,7 is roughly the same diameter and is made of the same 8.8 grade steel as the M8 bolts supplied with most plate hangers intended for use with Spits and so has a similar strength. That strength is above the requirement of both the CE (15 kN) and the UIAA (20 kN) standards for mountaineering anchors. The two larger screws exceed double the requirement.

The MMS 7,7 will drop through a standard 8 mm plate hanger but is not captive. The larger screws can be screwed through an 8 mm plate hanger with minimal damage to the hanger and will be captive.

They should be installed following the manufacturer's instructions which describes the procedure for hole cleaning and states the recommended tightening torques. Fischer state that tightening without using a torque wrench is permissible. It would be impracticable to use a torque wrench in a cave so in practice the tightening torque would be down to the judgement of the user. Over-tightening would seriously compromise safety. They should be tightened just enough to not come undone during normal use and no more.

Both Fischer and Heco state that their concrete screws can be reused after inspection of the thread and a thread checking gauge is available for both types of screw. However, both companies make no mention of reusing the same hole. Using a different type of screw in a previously used hole would compromise the strength of the anchor because they have different thread pitches.

Both the FBS 8x70 and the MMS 10x70 use an 8 mm diameter drill. The MMS 7,7x60 uses a 6 mm drill. Even the smallest SDS hammer drill will drill a large number of holes with a single battery. Concrete screws take less equipment and are simpler and quicker to install than any other type of anchor. Most importantly, they should be the first choice on conservation grounds. After removal they leave nothing behind but a small hole which can be used again and can be used for a more permanent anchor if need be.

At the time of writing the MMS 7,7x60 cost about 30p each when bought in boxes of 50. The MMS 10.70 costs 80p each in boxes of 25 and the FBS 8x70 costs 60p each in boxes of 50.

Simon Wilson, January 2018.

Appendix: Concrete Screws Available in the UK.

Fischer FBS II
Carries an ETA. Manufacturing plant stated as Fischer factory in Germany.
Fischerwerke GmbH & Co. KG, Klaus-Fischer-Straße 1, 72178 Waldachtal.

Heco Multi-Monti
Carries an ETA. Manufacturing plant stated as Heco factory in Germany.
HECO-Schrauben GmbH & Co. KG, Dr.-Kurt-Steim-Straße 28, D-78713 Schramberg.

Hilti Screw Anchor
Carries an ETA. Manufacturing plant stated as Hilti factory in Lichtenstien.

Rawlbolt R-LX Concrete Screwbolt
Rawlbolt website states: New product. Approvals and reports pending.

Thunderbolt and **Ankerbolt**
Both are marketed in the UK by subsidiaries Henstone Limited.
Both included in the same ETA.
Manufacturing plant stated as Zhang Chen Enterprise Co., Ltd. Taiwan.

Excalibur Screwbolt
Marketed in the UK by Excalibur Screwbolts Ltd
Carries an ETA. Manufacturing plant stated as "44-115". (no address)

DEWALT Blue-Tip Screwbolt
Carries an ETA. Manufacturing plant stated as "Manufacturing plant 1". (no address)

SPIT Tapcon
Carries an ETA. Manufacturing plant stated as “Plant 1”. (no address)

Forgefix Lightning-bolts
Forgefix website has no mention of ETA.