Loading and anchors

In 1995 the CNCC Technical Group set a test bed of Eco anchors using Exchem's Resifix 3+ as the bonding agent. The test bed was initially set because of the change in legislation that prevented Hilti for using styrene in the production process.

The Eco anchor is a 'P' shaped anchor with a double shaft manufactured 8mm - 316 stainless steel bar.

The test bed was installed in mass limestone with variables, and an industrial anchor tester was employed to pull the anchors to industry standards.

The system that had been developed by the CNCC Technical Group and subsequently adopted by the National Caving Association was used to install all the anchors. The ultimate failure loading of the anchor varied, as we expected, with regard to cleanliness of hole etc.

Anchor No.	Anchor egress kN	Load applied kN	Hole prep'	Note
1	36.0	46.8	B-A	1
2	46.8	54.0	W-B-D	
3	25.2	29.0	F-We	2
4	36.0	54.0	W-B-D	
5	45.0	52.2	W-B	3
6	36.0	48.6	W-B-D	
7	23.4	36.8	B-A	4
8	45.0	50.4	B-A	
9	54.0	54.0	B-A	
10	34.2	44.0	B-A	
11	18.0	40.0	B-A	
12	34.2	37.8	W-B-D	

Preparation codes: B - hole brushed out
A - compressed air used to expel dust
D – Died with absorbent cloth
W – hole washed flushed with water
We – hole was left wet

Notes:

1: Cementation of limestone particles has occurred, difficult to clean thoroughly

2: Only cleaning was flushing with water

3: Hole was drilled vertically into the floor, cleaned, then filled with water. The resin was used to expel the water.

4: Cementation of limestone particles has occurred, difficult to clean thoroughly.

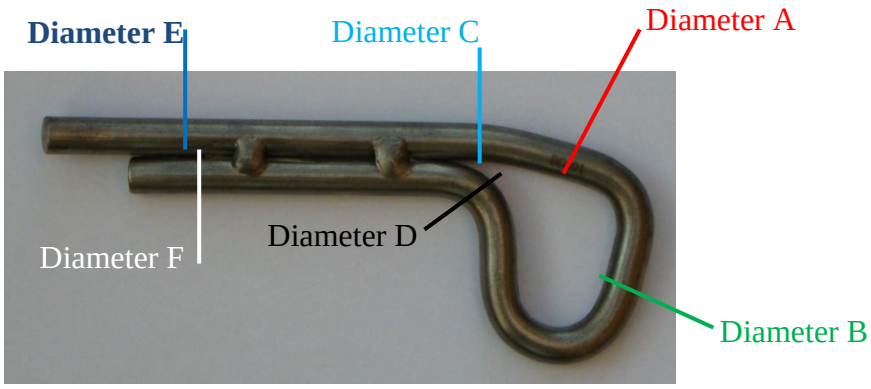
At a recent anchor installers installation seminars, the discussion got around to anchors and metal fatigue. So out of interest, we decided to examine specific diameters of the twelve anchors that had been loaded to the ultimate failure load and pulled from the rock.

It is quite apparent that certain parts of the Eco anchor undergo local extrusion at specific points. The degree of reduction of the diameter is consistent with the amount of loading and the direction of loading. I should add at this point that all these anchors we loaded in an axial pull.

The diagrams and tables below should give you an insight into the stresses that result in reduction of specific diameters during loading.

Each Eco anchor from the test bed dated 17 August 1995 has had specific diameters measured. The areas from where the measurements were taken are indicated below on the diagram of the Eco anchor.

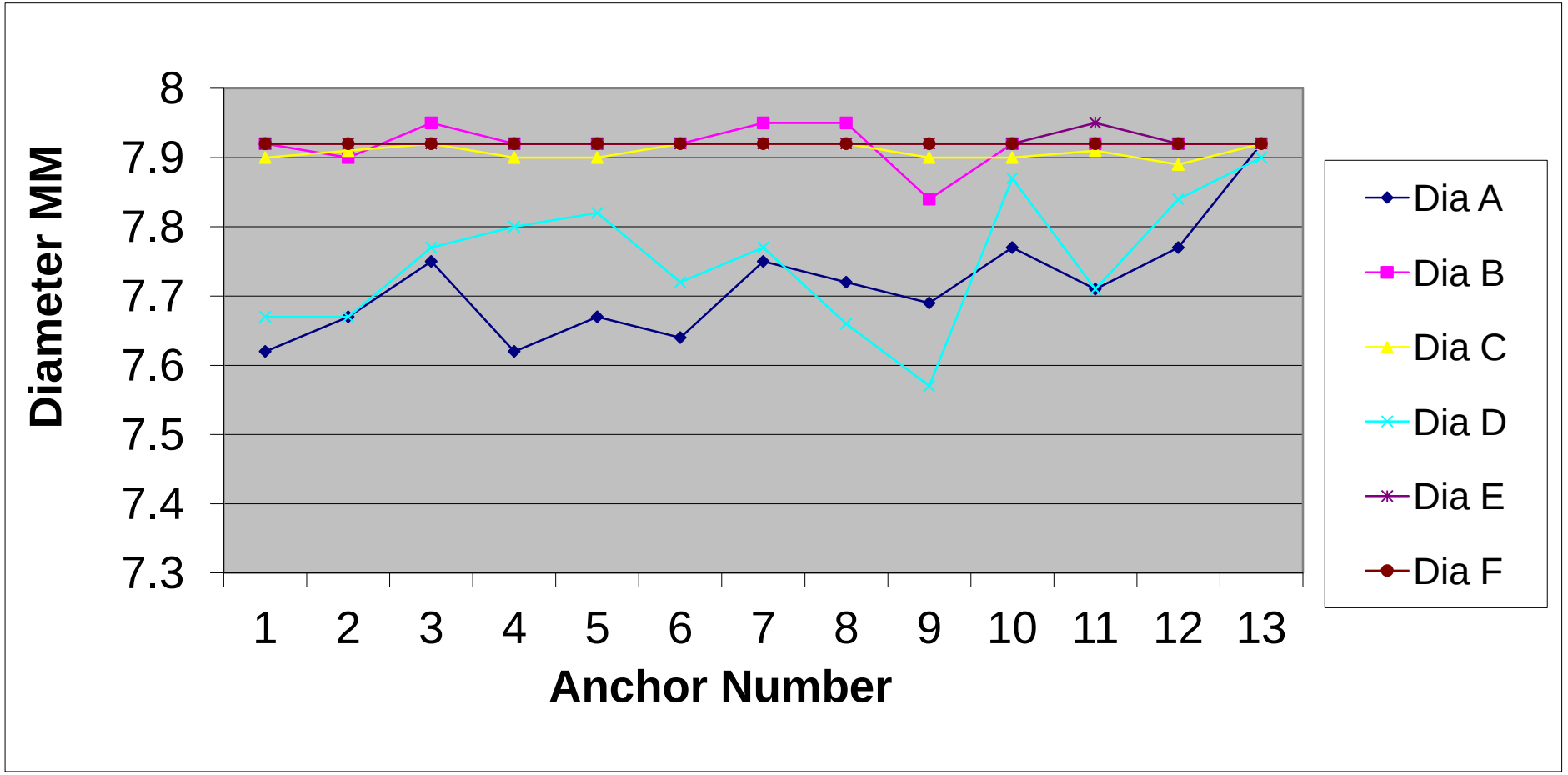
The reduction in the measurements at the point diameter D, we believe is caused by the manufacturing process and although a reduction means a reduced maximum load, significant work-hardening will make up for any loss. But it may become more brittle in this area.



Research by Stu Goodwill & Les Sykes
Report compiled by Les Sykes

Anchor	Egress (kN)	Max Load (kN)	Diameter A	Diameter Reduction (mm)	% Diameter Reduction		Diameter B	Diameter Reduction (mm)	% Diameter Reduction		Diameter C	Diameter Reduction (mm)	% Diameter Reduction		Diameter D	Diameter Reduction (mm)	% Diameter Reduction		Diameter E	Diameter Reduction (mm)	% Diameter Reduction		Diameter F	Diameter Reduction (mm)	% Diameter Reduction
1	36	46.8	7.62	0.3	3.79		7.92	0	0		7.9	0.02	0.25		7.67	0.25	3.16		7.92	0	0		7.92	0	0
2	46.8	54	7.67	0.25	3.16		7.9	0.02	0.25		7.91	0.01	0.13		7.67	0.25	3.16		7.92	0	0		7.92	0	0
3	25.2	29	7.75	0.17	2.15		7.95	-0	-0.38		7.92	0	0		7.77	0.15	1.89		7.92	0	0		7.92	0	0
4	36	54	7.62	0.3	3.79		7.92	0	0		7.9	0.02	0.25		7.8	0.12	1.52		7.92	0	0		7.92	0	0
5	45	52.2	7.67	0.25	3.16		7.92	0	0		7.9	0.02	0.25		7.82	0.1	1.26		7.92	0	0		7.92	0	0
6	36	48.6	7.64	0.28	3.54		7.92	0	0		7.92	0	0		7.72	0.2	2.53		7.92	0	0		7.92	0	0
7	23.4	36.8	7.75	0.17	2.15		7.95	-0	-0.38		7.92	0	0		7.77	0.15	1.89		7.92	0	0		7.92	0	0
8	45	50.4	7.72	0.2	2.53		7.95	-0	-0.38		7.92	0	0		7.66	0.26	3.28		7.92	0	0		7.92	0	0
9	54	54	7.69	0.23	2.9		7.84	0.08	1.01		7.9	0.02	0.25		7.57	0.35	4.42		7.92	0	0		7.92	0	0
10	34.2	44	7.77	0.15	1.89		7.92	0	0		7.9	0.02	0.25		7.87	0.05	0.63		7.92	0	0		7.92	0	0
11	18	40	7.71	0.21	2.65		7.92	0	0		7.91	0.01	0.13		7.71	0.21	2.65		7.95	-0.03	-0.38		7.92	0	0
12	34.4	37.8	7.77	0.15	1.89		7.92	0	0		7.89	0.03	0.38		7.84	0.08	1.01		7.92	0	0		7.92	0	0
new			7.92	0	0		7.92	0	0		7.92	0	0		7.9	0.02	0.25		7.92	0	0		7.92	0	0

Ave	**36.17**	**45.63**	**7.72**	**0.2**	**2.58**		**7.92**	**0**	**0.01**		**7.908**	**0.012**	**0.15**		**7.75**	**0.17**	**2.13**		**7.92**	**-0**	**-0.03**		**7.92**	**0**	**0**


Diameter MM
8
7.9
7.8
7.7
7.6
7.5
7.4
7.3
1
2
3
4
5
6
7
8
9
10
11
12
13
Anchor Number
Dia A
Dia B
Dia C
Dia D
Dia E
Dia F