ANCHORS MONITORING WITH LOAD CELLS

MONITORING WITH "DE and DS" LOAD CELLS

Ground anchors can be installed with a monitoring facility. Where a structure is sensitive to changes in load or ground movement use can be made of this facility to monitor the behaviour throughout its design life. The number of anchors to be monitored and the measurement interval must be specified.

Note:
In certain cases do to structural movement, it may be necessary to restress anchors periodically to keep the residual anchor force above the minimum required level. The corrosion protection of the accessible parts of the anchors heads shall be inspected periodically and renewed, if necessary.

"DE and DS" electrical cells on TTM anchorages

("DE and DS" electrical load cells)

DE and **DS** toroidal compression load cells are used to control the tensioning of anchors in rocks or soil; they also useful to keep anchors under control by revealing any tension losses or overloads. When subjected to a load, the cell will undergo a deformation that is measured by strain gauges, which produce an output electric signal proportional to the applied load by varying their resistance values.
DE and **DE-S** cells are completely encapsulated, they are provided with a IP68 screw connector and a shielded wire having a length on request.
They are made of stainless steel so they do not need the coverage with caps. They can be left bare without any protection under the anchor plate.

Electrical load cells are supplied in two versions:

- **DE** electrical cells with special dimensions;
- **DE-S** standard cells with basic dimensions.

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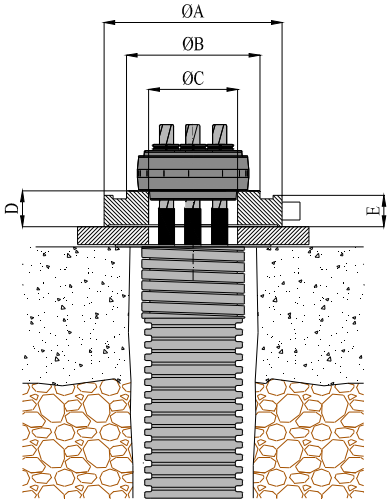
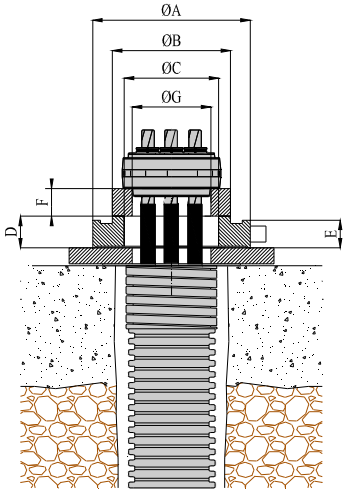
DE and DS cells characteristics

Capacity fs	from 500 to 3,000 kN
End-scale output/Rated output	2.0 mV/V ± 0.1%
Power supply/Nominal excitation range	5÷10V (max. 15V)
Zero balance output	≤ ± 1% f.s.
Input resistance	1,450 ± 50 Ω
Insulation resistance	> 5 GΩ
Combined error	≤ ± 0.2 % f.s.
Non repeatability	≤ ± 0.015 % f.s.
Temperature effect on zero balance (5K)	≤ ± 0.01 % f.s.
Temperature Effect on rated output (5K)	≤ ± 0.01 % f.s.
Compensated temperature range	- 10 °C ÷ +50°C
Operating temperature range	- 20 °C ÷ +70°C
Max. safe load	150% f.s.
Ultimate load	> 300% f.s.
Protection class (EN 60529)	IP68
Deflection at rated capacity	0.4 mm
Material	Stainless steel
Cable length	On request

DE and DS cells dimensions



DE cell



DS cell

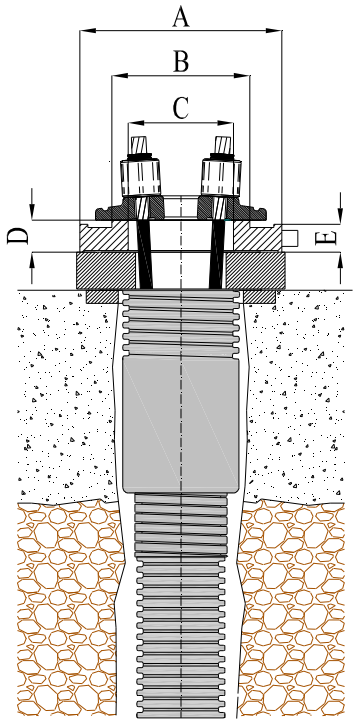
Type of cell	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)	F (mm)	G (mm)	Weight (kg/pc.)	Strands	Max. load (kN)
DE1000kN	155	105	83.00	40	35.5	*****	*****	4.5	4	1200
DE1200kN	183	125	101.00	40	35.5	*****	*****	5.5	7	1500
DE1800kN	230	146	123.00	40	35.5	*****	*****	9	9	2000
DE2100kN	230	160	140.00	40	35.5	*****	*****	8.5	12	2500
DE2500kN	260	176	150.00	40	35.5	*****	*****	12	15	3000
DS750kN	229	150	120	45	40	20	83.00	9	4	1000
DS1000kN	229	150	120	45	40	25	83.00	9	4	1200
DS1250kN-A	229	165	120	45	40	25	102.00	9	7	1500
DS1250kN-B	275	165	165	45	40	30	102.00	14	7	1500
DS1500kN	275	215	165	45	40	30	123.00	14	9	2000
DS1800kN-A	275	250	165	45	40	30	140.00	14	12	2500
DS1800kN-B	320	250	225	55	50	35	140.00	20	12	2500
DS2500kN	320	250	225	55	50	35	150.00	20	15	3000

"DE and DS" electrical cells on TTR-E anchorages

DE-S S load cell on a distribution plate where a 6TTR-E plate is placed. The system is provided with a short protection cap.
DE-S are provided with a IP67 screw connector and a shielded wire having a length on request.
They are made of stainless steel so they do not need the coverage with caps. They can be left bare without any protection under the anchor plate.

Capacity fs	from 500 to 2,500 kN
Nominal sensitiveness	2.0 mV/V ± 0.1%
Power supply/Nominal excitation range	2÷15 Vcc/ca
Output resistance	700 ± 5 Ω
Input resistance	700 ± 20 Ω
Insulation	> 5 GΩ
Combined error	± 0.10 % f.s.
Repeatability	± 0.02 % f.s.
Nominal load creep (20')	± 0.03 % f.s.
Temperature effect on zero balance	< ± 0.005 % f.s./°C
Temperature effect on rated output	< ± 0.005 % f.s./°C
Compensated temperature range	- 10 °C ÷ +50°C
Operating temperature range	- 20 °C ÷ +70°C
Max. safe load	150% f.s.
Ultimate load	> 300% f.s.
Protection class (EN 60529)	IP67
Deflection at rated capacity	0.4 mm
Material	Stainless steel
Cable length	On request

Dimensions of DE-S cells on TTR-E anchorages



The area between the cap and the load cell must be sealed with silicone.

Cell type	Code	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)	Weight (Kg/pc.)	Strands	Max. load (KN)
DE-S 750kN	40070	229	150	125	45	40	9	2-3-4	750
DE-S 1200kN	40071	275	195	170	45	40	14	5-6	1200
DE-S 1500kN	40072	320	250	225	45	40	20	7-8	1500

Reading device for "DE-S" cells

(Reading device for TTR-E-DES cells TT1000 type)

Wire diagram		
Cable		**Cable**
White	**- OUT**	White
Green	**+ OUT**	Green
Red	**+ IN**	Red
Black	**- IN**	Black
Blue	**+ REF**	Blue
Brown	**- REF**	Brown

The **DE-S** load cells must be placed on a flat, indeformable surface to ensure cell loading from the anchorage to the surface, with no punctiform transfers, no coupling with irregular surfaces and no transverse components. For the cell to work properly, the load must be applied perpendicular to the cell and the drilling hole must be made with particular attention, with no deviation from the drilling nor mistakes on the drilling angle with respect to the load supporting plane.
Cells require all the strands to be tensioned at the same time to guarantee an even distribution of the load. The cell gives a reading in KN directly.
The applied load reading suffers from various losses, so with a calibrated hydraulic pump, at the load application its loss is read after locking of 30% - 40% or even greater. The loss is directly proportional to extension of the ground anchor, it is as big as the free length will be short and the tensioning value applied to the ground anchor is small.
While tensioning, as the recorded load loss must be recovered, the anchor is re-tensioned by over-tensioning it, considering that the tensioning limits of the wire must not be exceeded.
By over-retensioning it, the load loss in the system will be recovered to guarantee the correct final applied load, as planned.
All systems suffer from losses and their extent is given by the containment of the single losses.

MONITORING WITH "DI" LOAD CELLS

Ground anchors can be installed with a monitoring facility. Where a structure is sensitive to changes in load or ground movement use can be made of this facility to monitor the behaviour throughout its design life. The number of anchors to be monitored and the measurement interval must be specified.

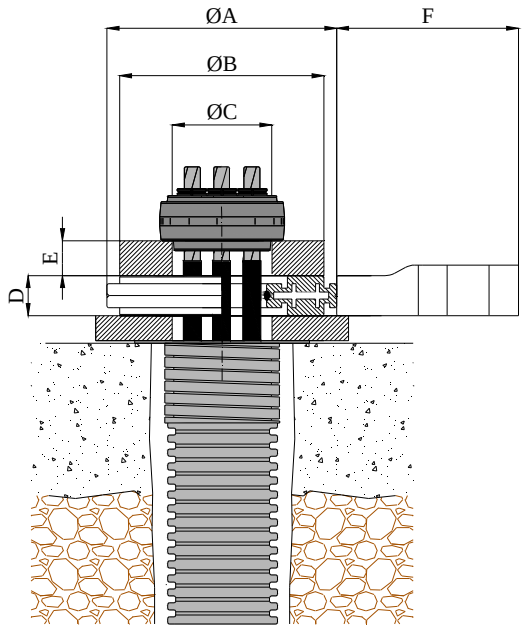
Note:

In certain cases do to structural movement, it may be necessary to restress anchors periodically to keep the residual anchor force above the minimum required level. The corrosion protection of the accessible parts of the anchors heads shall be inspected periodically and renewed, if necessary.

"DI" load cells are hydraulic, without gaskets and they are made of AISI 304 steel. These characteristics make them especially suitable for use in monitoring the long-term tension of permanent anchors.

The load cell must be placed on a flat, indeformable surface to ensure cell loading from the anchorage to the surface, with no punctiform transfers, no coupling with irregular surfaces and no transverse components.

Dimensions of DI load cells with TTM anchorage



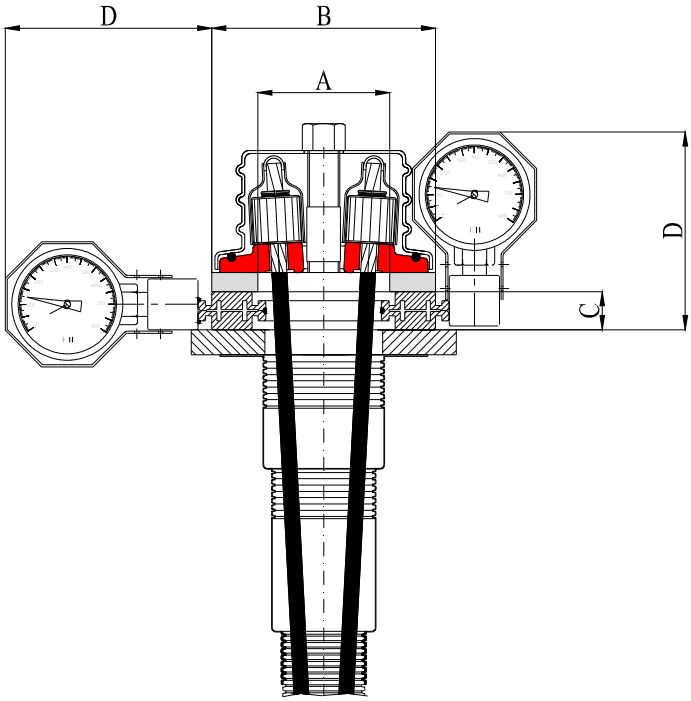
* approximate measure

Cell type	A (mm)	B* (mm)	C (mm)	D (mm)	E (mm)	F (mm)	N° di trefolo	Carico max. (KN)
DI750KN	204	186	85.00	40.00	20	195	2-4	750
DI1000KN	228	218	110.00	40.00	25	195	2-4	1000
DI1500KN	293	283	130.00	40.00	30	195	5-9	1500
DI2500KN	380	370	150.00	40.00	35	195	9-12	2500

Dimensions of DI load cells with TTR-E anchorage

("DI" hydraulic load cells)

The **DI** load cell must be placed on a flat, indeformable surface to ensure cell loading from the anchorage to the surface with no punctiform transfers, no coupling with irregular surfaces and no transverse components.



The area between the cap and the load cell must be sealed with silicone.

* approximate measure

Type (KN)	Model	A (mm)	B* (mm)	C (mm)	D (mm)	Precision	Overload	Material	Unit weight (Kg)
1000	**DI-1000SkN**	135	250	40	195	+/- 1% F.S.	120 %	AISI 304	7.5
1500	**DI-1500kN**	160	300	40	195	+/- 1% F.S.	120 %	AISI 304	10
2500	**DI-2500kN**	180	360	40	195	+/- 1% F.S.	120 %	AISI 304	16
2500	**DI-2500SkN**	220	380	40	195	+/- 1% F.S.	120 %	AISI 304	16

Anchorage	Cell type	Cell load (kN)	Max. cell load (kN)	Strand dimensions diam. (mm)
2TTR-E15	**DI-1000SkN**	1000	1200	125
3TTR-E15	**DI-1000SkN**	1000	1200	125
4TTR-E15	**DI-1000SkN**	1000	1200	125
5TTR-E15	**DI-1500kN**	1500	1800	145
6TTR-E15	**DI-1500kN**	1500	1800	168
7TTR-E15	**DI-2500SkN**	2500	1800	194
8TTR-E15	**DI-2500SkN**	2500	3000	215

Characteristics of DI cells

("DI" hydraulic load cells)

Capacity load	from 750 to 2.500 kN
Scale end precision for analogue reading	± 1% scale end
Resolution	< 0.2% FS
Error due to temperature with a difference of 25 °C	< 1.5% scale end
Allowable overload with deviation from zero < 2% of scale end	120%
Type of material	AISI 304

For the cell to work properly, the load must be applied perpendicular to the cell and the drilling hole must be made with particular attention, with no deviation from the drilling nor mistakes on the drilling angle with respect to the load supporting plane. Cells require all the strands to be tensioned at the same time to guarantee an even distribution of the load. The cell gives a reading in KN directly. The applied load reading suffers from various losses, so the gauge on the side of the cell shows the load and its loss is read after locking of 30% - 40% or even greater. The loss is directly proportional to extension of the ground anchor, it is as big as the free length will be short and the tensioning value applied to the ground anchor is small.
While tensioning, as the recorded load loss must be recovered, the anchor is re-tensioned by over-tensioning it, considering that the tensioning limits of the wire must not be exceeded. By over-retensioning it, the load loss in the system will be recovered to guarantee the correct applied load, as planned. All systems suffer from losses and their extent is given by the containment of the single losses.

Reading interpretation

The reading of the value shown on the load cell is affected by the sum of the following losses:

- loss due to locking, (re-entering of wedges $P_{locking}$);
- losses in the jack, (extensions of the jack P_{jack});
- losses due to angle deviation, (deviation of the anchorage $P_{angle\ dev.}$);
- losses due to offset load, (small transverse components $P_{transverse}$).

$P_{Tot.} = P_{locking} + P_{jack} + P_{angle\ dev.} + P_{transverse}$

$P_{Tot.}$ represents the total load losses.

While tensioning, taking account of the load loss read on the first anchor, the anchor is re-tensioned. By over-retensioning it, the load loss in the system will be recovered to guarantee the correct load applied, as planned.