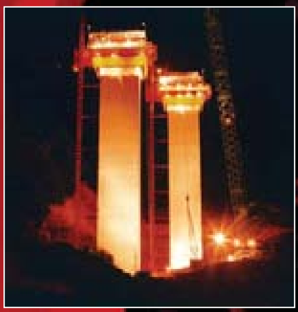
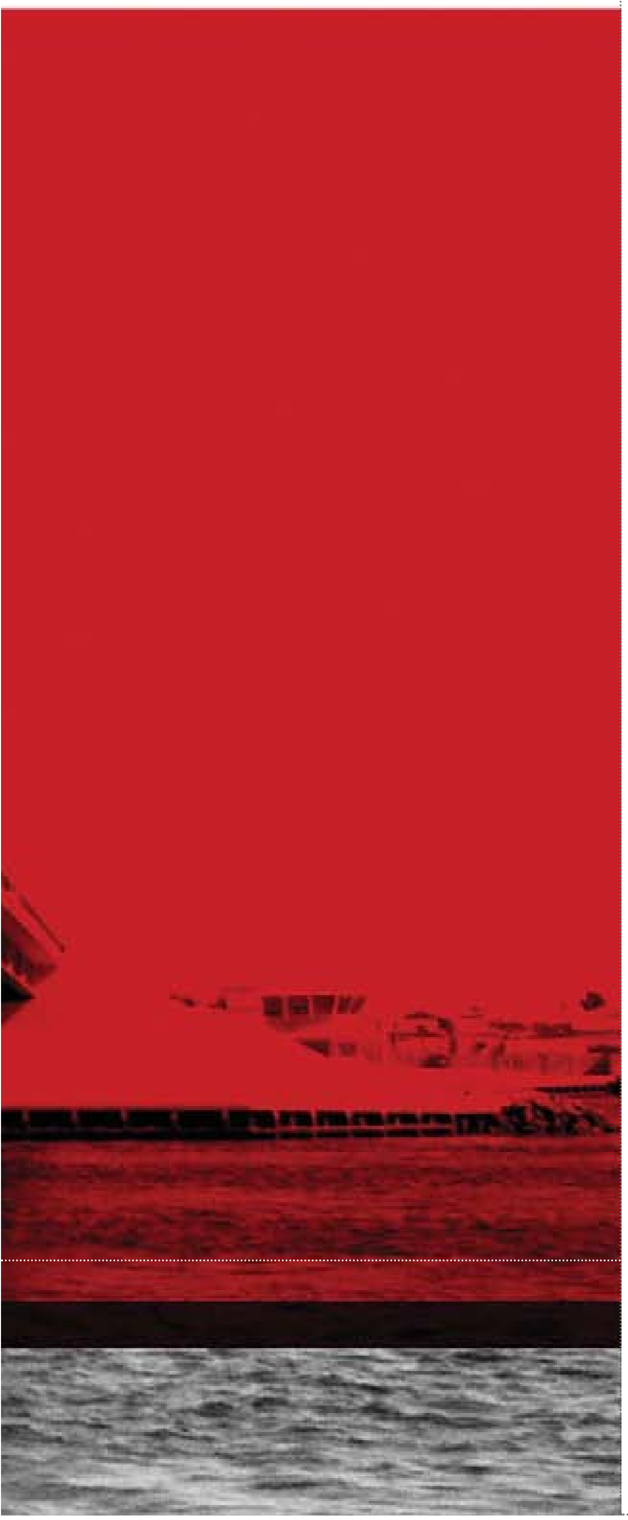
POST-TENSIONING SYSTEMS

CIVIL ENGINEERING CONSTRUCTION

CCL Post Tensioning®

CCL extends the limits of construction techniques used to enhance the built environment. At CCL, the Company works to improve the performance of construction allowing its partners to design and build more efficient and durable structures, more rapidly, for the benefit of individuals and the community.

CCL

CCL EXPERIENCE

CCL is committed to the design, manufacture, supply and installation of innovative, world-class post-tensioning systems. Working for clients across the world, CCL has the experience and a proven ability to create solutions that help reduce timescales and deliver exceptional results.

CCL QUALITY

Committed to a programme of continuous research and development, CCL delivers an exceptional service tailored to local and regional conditions and regulations. The Company operates a Quality Management System that complies with BS EN ISO 9001 and all products are designed individually to exacting standards using high specification materials from approved sources. CCL uses the latest design software and FEA and is approved and tested to the latest ETAG and AASHTO requirements.

CCL COMMITMENT

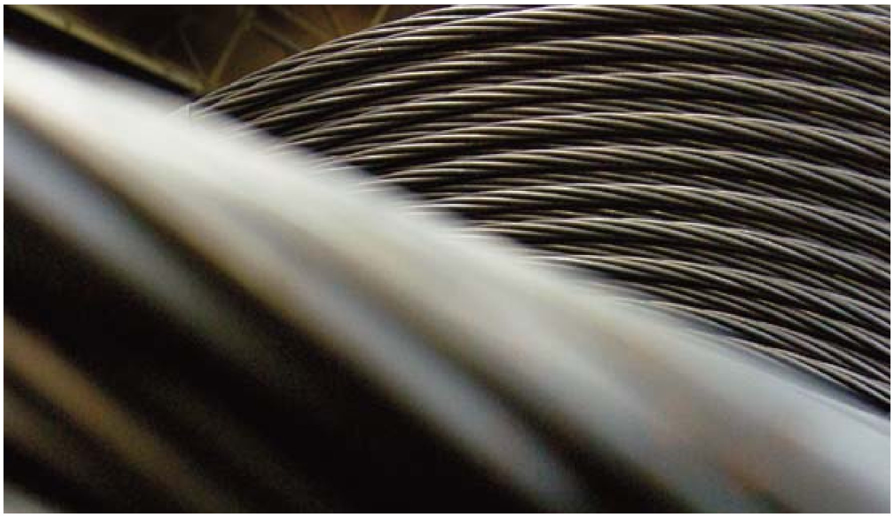
Involved in projects from conception, CCL offers assistance to help clients meet the requirements of the structure and local technical standards. The Company adds value throughout the project in terms of design, construction, systems, equipment and implementation. CCL has a reputation for delivering a responsive, flexible, cost-effective service and high quality civil engineering solutions worldwide.

CCL SERVICE

CCL operates a fully integrated supply chain through its own group companies to ensure quality from conception to construction and beyond. Its local companies and licensees have access to the CCL engineering, construction and supply resources to offer an optimal solution suited to the local market.

CCL's global presence, experience and expertise enables the Company to offer clients a local solution backed by international engineering and construction techniques. CCL's philosophy is simple to offer the client the best solution in terms of design, supply and construction for their market and project.

The strand is manufactured from seven cold drawn wires, termed a '7 wire pre-stressing strand'. It has a straight central wire, called a core or king wire, around which six wires are spun in one layer. The outer wire is tightly spun around the central wire with a lay length between 14 and 18 times the nominal strand diameter. The diameter of the central wire is at least 3 per cent greater than the diameter of the outer helical wires. Strands are supplied to site typically in 3-4 tonne coils.



prEN 10138 - 3 : 2006

Steel Designation	Nominal Dia mm	Tensile Strength MPa	Steel Area mm²	Nominal Mass Kg/m	Breaking Load F_m kN	0.1% Proof Load F_p 0.1 kN	Max Strand Load F_o kN
Y1770S7	12.5	1770	93	0.730	165	145	132
Y1860S7	12.5	1860	93	0.730	173	152	138
Y1860S7G	12.7	1860	112	0.875	208	183	167
Y1770S7	12.9	1770	100	0.781	177	156	142
Y1860S7	12.9	1860	100	0.781	186	164	149
Y1860S7	13.0	1860	102	0.797	190	167	152
Y1770S7	15.2	1770	139	1.086	246	216	197
Y1860S7	15.2	1860	139	1.086	259	228	207
Y1820S7G	15.2	1820	165	1.289	300	264	240
Y1770S7	15.3	1770	140	1.093	248	218	198
Y1860S7	15.3	1860	140	1.093	260	229	208
Y1770S7	15.7	1770	150	1.172	266	234	212
Y1860S7	15.7	1860	150	1.172	279	246	223

ASTM A 416/A 416M - 06

Steel Designation	Nominal Dia		Tensile Strength		Cross Sectional Area		Breaking Load	
Dia (Grade)	in	mm	ksi	MPa	in²	mm²	lbf	kN
13 (250)	0.500	12.7	250	1725	0.144	92.9	36000	160.1
15 (250)	0.600	15.2	250	1725	0.216	139.4	54000	240.2
13 (270)	0.500	12.7	270	1860	0.153	98.7	41300	183.7
15 (270)	0.600	15.2	270	1860	0.217	140.0	58600	260.7

Maximum relaxation after 1000 hours for % characteristic breaking load 60% = 1%, 70% = 2.5%, 80% = 4.5%.

XM range...

CCL's world-class product development ensures the specification and mechanical properties of the CCL XM Multistrand Post-tensioning range are second to none. Versatile, lightweight, compact but immensely strong, CCL's range of bespoke and standard solutions gives engineers and contractors the flexibility they need to deliver cutting-edge contemporary structures on time and in budget.

The type of anchorage is designated depending on its function in the structure in the following order:

The type of anchorage is designated by type and size in the following order:

XM	-	20	-	5	-	13
System Type		Anchorage Size		Maximum No. of Strands		Nominal Diameter

Example:
XM-60-19-15.7-L – Live End Multistrand Anchorage with a size 60 Force Transfer Unit having 19 strands of Ø15.7mm.

13mm Tendons

Anchorage	No.of Strands	Ø Strand
XM-10	4	12.5/12.9/13.0
XM-20	6	12.5/12.9/13.0
XM-30	9	12.5/12.9/13.0
XM-35	12	12.5/12.9/13.0
XM-40	18	12.5/12.9/13.0
XM-45	19	12.5/12.9/13.0
XM-50	22	12.5/12.9/13.0
XM-55	25	12.5/12.9/13.0
XM-60	27	12.5/12.9/13.0
XM-70	31	12.5/12.9/13.0
XM-75	37	12.5/12.9/13.0
XM-80	40	12.5/12.9/13.0
XM-90	46	12.5/12.9/13.0
XM-95	51	12.5/12.9/13.0
XM-100	55	12.5/12.9/13.0

15mm Tendons

Anchorage	No.of Strands	Ø Strand
XM-10	3	15.2/15.3/15.7
XM-20	4	15.2/15.3/15.7
XM-30	7	15.2/15.3/15.7
XM-35	9	15.2/15.3/15.7
XM-40	12	15.2/15.3/15.7
XM-45	13	15.2/15.3/15.7
XM-50	15	15.2/15.3/15.7
XM-55	17	15.2/15.3/15.7
XM-60	19	15.2/15.3/15.7
XM-70	22	15.2/15.3/15.7
XM-75	25	15.2/15.3/15.7
XM-80	27	15.2/15.3/15.7
XM-90	31	15.2/15.3/15.7
XM-95	35	15.2/15.3/15.7
XM-100	37	15.2/15.3/15.7

It is possible to use CCL XM Anchorages with a number of strands fewer than the maximum number specified. In this case, intermediate units can be modified from the existing designs provided strands lie as symmetrically as possible around the anchor head to ensure the force is safely centred.

XM range 13mm...

Anchorage	No. of Strands	12.5mm				12.9mm				13mm		12.7mm Compact	
		Grade 1770		Grade 1860		Grade 1770		Grade 1860		Grade 1860		Grade 1860	
		F_{pk} kN	P_{max} kN	F_{pk} kN	P_{max} kN	F_{pk} kN	P_{max} kN	F_{pk} kN	P_{max} kN	F_{pk} kN	P_{max} kN	F_{pk} kN	P_{max} kN
XM-10	4	658	527	692	554	708	566	744	595	759	607	833	667
XM-20	6	988	790	1038	830	1062	850	1116	893	1138	911	1250	1000
XM-30	9	1481	1185	1557	1245	1593	1274	1674	1339	1707	1366	1875	1500
XM-35	12	1975	1580	2076	1661	2124	1699	2232	1786	2277	1821	2500	2000
XM-40	18	2963	2370	3114	2491	3186	2549	3348	2678	3415	2732	3750	3000
XM-45	19	3128	2502	3287	2629	3363	2690	3534	2827	3605	2884	3958	3166
XM-50	22	3621	2897	3806	3044	3894	3115	4092	3274	4174	3339	4583	3666
XM-55	25	4115	3292	4325	3460	4425	3540	4650	3720	4743	3794	5208	4166
XM-60	27	4444	3556	4670	3736	4779	3823	5022	4018	5122	4098	5625	4500
XM-70	31	5103	4082	5362	4290	5487	4390	5766	4613	5881	4705	6458	5166
XM-75	37	6091	4872	6400	5120	6549	5239	6882	5506	7020	5616	7708	6166
XM-80	40	6584	5268	6919	5535	7080	5664	7440	5952	7589	6071	8333	6666
XM-90	46	7572	6058	7957	6366	8142	6514	8556	6845	8727	6982	9583	7666
XM-95	51	8395	6716	8822	7058	9027	7222	9486	7589	9676	7741	10624	8499
XM-100	55	9054	7243	9514	7611	9735	7788	10230	8184	10435	8348	11458	9166

Fpk and Pmax stated are respectively the ultimate breaking load and the maximum jacking load per anchorage. Actual values are contained in the national regulations set by each country.

XM range 15mm...

Anchorage	No. of Strands	15.2mm				15.3mm				15.7mm				15.2mm Compact	
		Grade 1770		Grade 1860		Grade 1770		Grade 1860		Grade 1770		Grade 1860		Grade 1820	
		F_{pk} kN	P_{max} kN	F_{pk} kN	P_{max} kN	F_{pk} kN	P_{max} kN	F_{pk} kN	P_{max} kN	F_{pk} kN	P_{max} kN	F_{pk} kN	P_{max} kN	F_{pk} kN	P_{max} kN
XM-10	3	738	590	776	620	743	595	781	625	797	637	837	670	901	721
XM-20	4	984	787	1034	827	991	793	1042	833	1062	850	1116	893	1201	961
XM-30	7	1722	1378	1810	1448	1735	1388	1823	1458	1859	1487	1953	1562	2102	1682
XM-35	9	2214	1771	2327	1861	2230	1784	2344	1875	2390	1912	2511	2009	2703	2162
XM-40	12	2952	2362	3102	2482	2974	2379	3125	2500	3186	2549	3348	2678	3604	2883
XM-45	13	3198	2559	3361	2689	3221	2577	3385	2708	3452	2761	3627	2902	3904	3123
XM-50	15	3690	2952	3878	3102	3717	2974	3906	3125	3983	3186	4185	3348	4505	3604
XM-55	17	4183	3346	4395	3516	4213	3370	4427	3541	4514	3611	4743	3794	5105	4084
XM-60	19	4675	3740	4912	3930	4708	3767	4948	3958	5045	4036	5301	4241	5706	4565
XM-70	22	5413	4330	5688	4550	5452	4361	5729	4583	5841	4673	6138	4910	6607	5285
XM-75	25	6151	4921	6464	5171	6195	4956	6510	5208	6638	5310	6975	5580	7508	6006
XM-80	27	6643	5314	6981	5584	6691	5352	7031	5625	7169	5735	7533	6026	8108	6486
XM-90	31	7627	6102	8015	6412	7682	6145	8072	6458	8231	6584	8649	6919	9309	7447
XM-95	35	8611	6889	9049	7239	8673	6938	9114	7291	9293	7434	9765	7812	10511	8408
XM-100	37	9103	7282	9566	7653	9169	7335	9635	7708	9824	7859	10323	8258	11111	8889

Fpk and Pmax stated are respectively the ultimate breaking load and the maximum jacking load per anchorage. Actual values are contained in the national regulations set by each country.

metal ducts...

In order to insert the strand tendons within the structure a void must be formed in the concrete. The most effective and economical way to do this is to cast metal spiral duct into the concrete at the desired position and profile. After the tendons have been stressed, the remaining void in the duct is grouted. This provides corrosion protection and bonds the tendons to the duct. The corrugations within the duct provide an excellent bond between the grouted tendons and the concrete structure.

Metal Duct

Corrugated sheaths are made from rolled sheet having a minimum thickness of 0.3mm. The usual guide for the required diameter of duct is 2.5 times the nominal area of the tendon (Strands). The recommended nominal diameter for each tendon is shown on page 5. These should be checked against the local requirements and regulations.

	Duct		Coupler							
Anchorage	Ø Inside mm	Ø Outside mm	Ø Inside mm	Ø Outside mm	Duct Weight Kg/m	Duct Length m	Duct Area mm²	Support Spacing mm	k rad/m	μ l/rad
XM-10	50	55	55	60	0.65	6	1900	1000		
XM-20	50	55	55	60	0.65	6	1900	1000		
XM-30	65	70	70	75	0.82	6	3300	1000		
XM-35	75	80	80	85	0.93	6	4400	1000		
XM-40	80	85	85	90	1.01	6	5000	1000		
XM-45	80	85	85	90	1.01	6	5000	1000		
XM-50	90	95	95	100	1.07	6	6300	1000	see page 33	see page 33
XM-55	100	105	105	110	1.19	6	7800	1000		
XM-60	100	105	105	110	1.19	6	7800	1000		
XM-70	100	105	105	110	1.19	6	7800	1000		
XM-75	115	120	120	125	1.31	6	10300	1000		
XM-80	115	120	120	125	1.31	6	10300	1000		
XM-90	125	130	130	135	1.45	6	12200	1000		
XM-95	140	145	145	150	1.63	6	15300	1000		
XM-100	140	145	145	150	1.63	6	15300	1000		

Duct weight is indicative and depends on the sheet thickness and manufacturing process.

plastic ducts...

Plastic Duct

Manufactured from High-Density Polyethylene (HDPE) or Polypropylene, the duct comes typically in 6m lengths and is connected using plastic couplers. The plastic duct should comply with the requirements of fib.

CCL supplies round plastic duct where enhanced corrosion protection or improved fatigue resistance is required. The ducts meet all the applicable requirements of the fib and the American DOT regulations. They provide an excellent secondary corrosion protection in aggressive environments.

Although supplied in 6 metre lengths for ease of transportation the duct can be manufactured to specific lengths or coils, as per the project requirements. It is connected using specific clam shell couplers with or without integrated grout vents for ease of installation and to provide secure joints.

Anchorage	Ø Duct Inside mm	Ø Duct Outside* mm	Duct Thickness mm	Duct Length m	Duct Area mm²
XM-10	48	59	2.0	6	1800
XM-20	48	59	2.0	6	1800
XM-30	59	73	2.0	6	2700
XM-35	76	91	2.5	6	4500
XM-40	76	91	2.5	6	4500
XM-45	76	91	2.5	6	4500
XM-50	85	100	2.5	6	5700
XM-55	100	116	3.0	6	7900
XM-60	100	116	3.0	6	7900
XM-70	100	116	3.0	6	7900
XM-75	115	135	3.5	6	10400
XM-80	115	135	3.5	6	10400
XM-90	130	151	4.0	6	13300
XM-95	130	151	4.0	6	13300
XM-100	145	-	-	6	16500

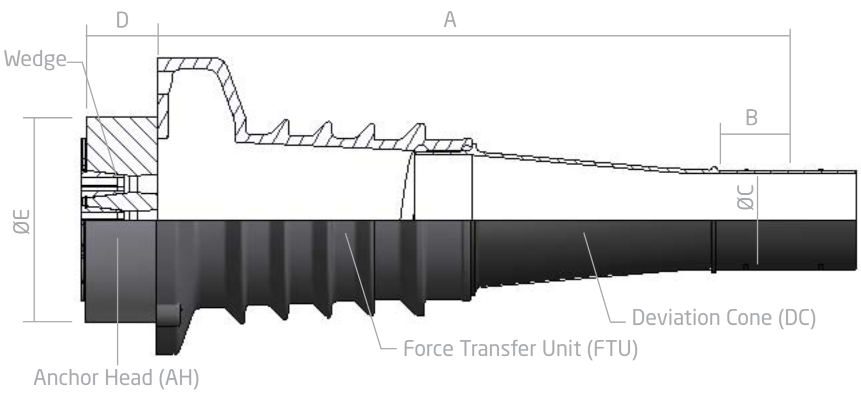
* Over corrugations.
Duct weight is indicative and depends on the sheet thickness and manufacturing process
For coeficient of friction and unintentional angular displacement please refer to page 33.

XM live end anchorage 13mm & 15mm...

The CCL XM Live End Anchorages (LE) are primarily designed for longitudinal tendons in beams or bridges.

Live end anchorages can be used as active or passive anchorages.

The strands of the anchorage are simultaneously stressed by a jack bearing on the force transfer unit (FTU) by means of a bearing ring (BR).



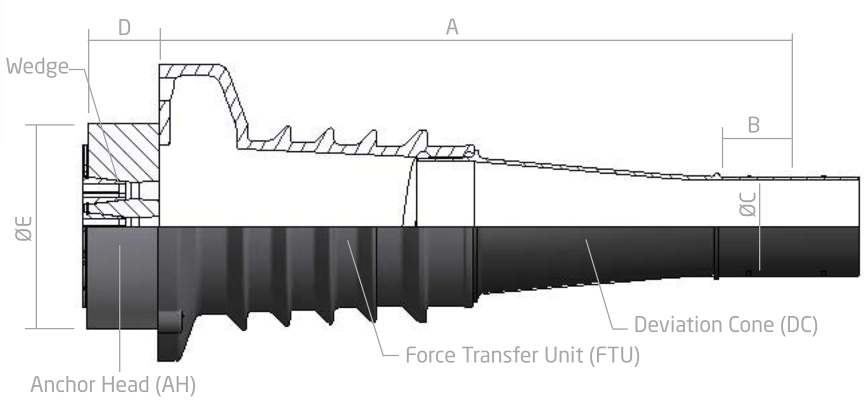
13mm Tendons							
Anchorage	**No. of Strands**	**A**	**B**	**Ø C**	**Ø Duct**	**D**	**Ø E**
XM-10	4	234	70	48	50/55	40	95
XM-20	6	300	70	50	50/55	40	105
XM-30	9	362	100	64	65/70	43	130
XM-35	12	493	113	74	75/80	48	155
XM-40	18	629	113	74	80/85	62	180
XM-45	19	629	113	74	80/85	67	180
XM-50	22	693	130	84	90/95	69	195
XM-55	25	742	150	98	100/105	67	215
XM-60	27	749	150	98	100/105	76	220
XM-70	31	913	150	98	100/105	74	245
XM-75	37	1001	175	113	115/120	80	265
XM-80	40	1001	175	113	115/120	84	270
XM-90	46	1118	190	123	125/130	87	295
XM-95	51	1079	210	138	140/145	97	305
XM-100	55	1089	210	138	140/145	98	310

All dimensions in mm

The pre-stressing force is applied to the strands and locked in place by the wedges in the anchor head (AH) which is supported on the force transfer unit (FTU) cast into the concrete.

The force transfer unit ensures the transmission of the pre-stressing force into the concrete.

The FTU and the deviation cone (DC) ensure the correct deviation of the strands from the anchor head to the duct.

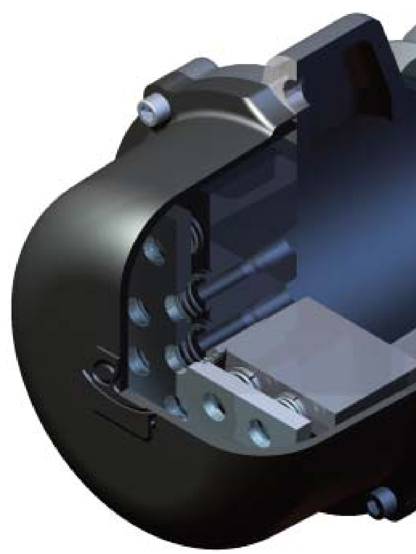


15mm Tendons							
Anchorage	**No. of Strands**	**A**	**B**	**Ø C**	**Ø Duct**	**D**	**Ø E**
XM-10	3	234	70	48	50/55	45	95
XM-20	4	300	70	50	50/55	45	105
XM-30	7	362	100	64	65/70	48	130
XM-35	9	493	113	74	75/80	47	155
XM-40	12	629	113	74	80/85	54	180
XM-45	13	629	113	74	80/85	63	180
XM-50	15	693	130	84	90/95	60	195
XM-55	17	742	150	98	100/105	62	215
XM-60	19	749	150	98	100/105	76	220
XM-70	22	913	150	98	100/105	70	245
XM-75	25	1001	175	113	115/120	80	265
XM-80	27	1001	175	113	115/120	83	270
XM-90	31	1118	190	123	125/130	94	295
XM-95	35	1079	210	138	140/145	94	305
XM-100	37	1089	210	138	140/145	102	310

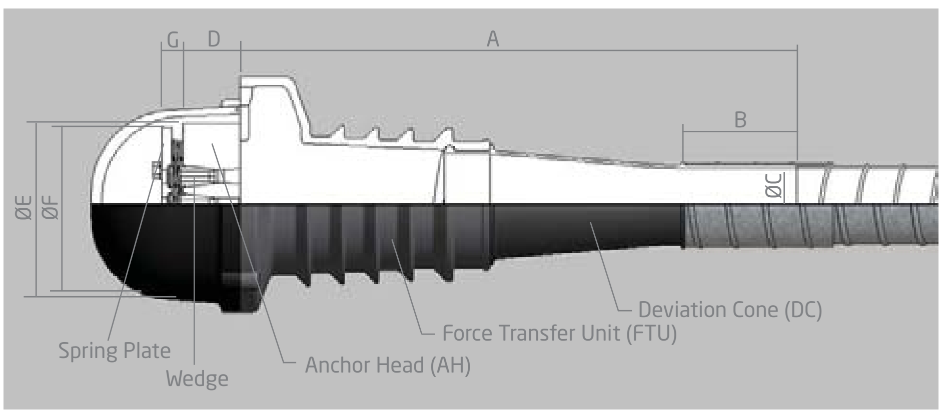
All dimensions in mm

XM dead end anchorage 13mm & 15mm...

The CCL XM Dead End Anchorage operates as a passive (non-stressing) end of the tendon. The wedges are locked in place by the spring plate while the pre-stressing force is applied to the opposite (live) end of the tendon. The pre-stressing force in the strands is locked by the wedges in the anchor head (AH) which is supported on the force transfer unit (FTU) cast into the concrete. If required dead end anchorages can be used as buried passive anchorages with the provision of a sealing cap and a suitable grout vent. Threading of the strands must be completed before concreting.

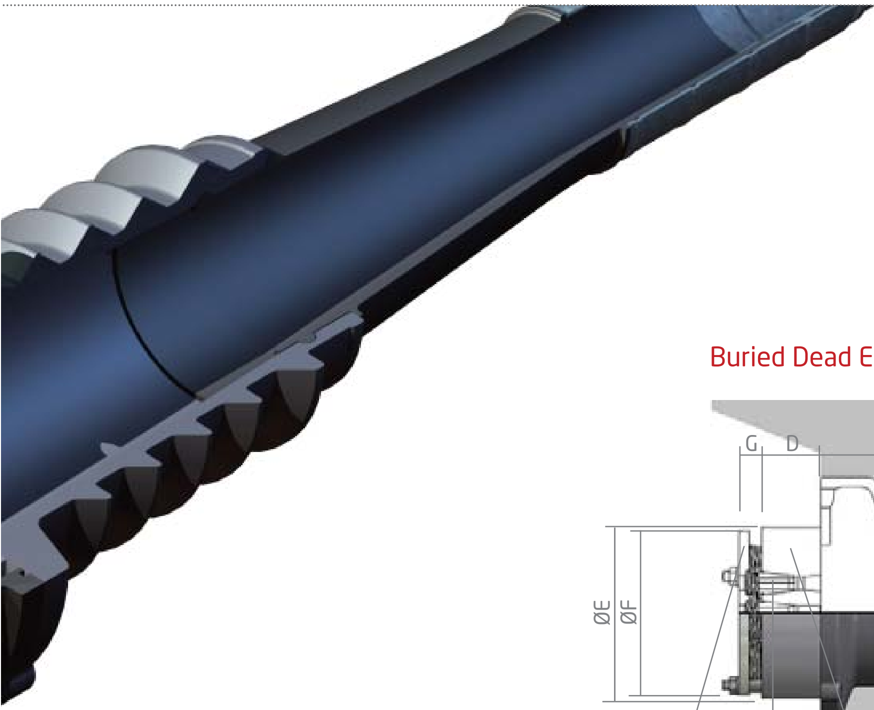


Passive Dead End



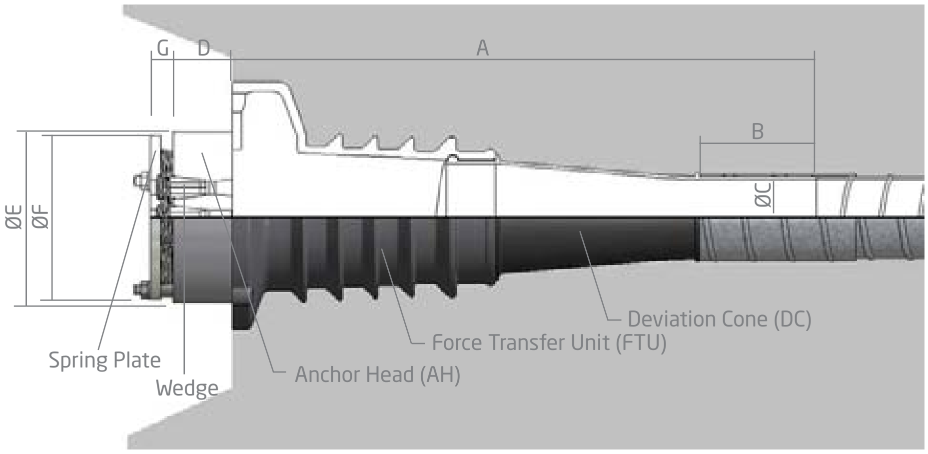
13mm Tendons									
Anchorage	No. of Strands	A	B	Ø C	D	Ø E	Ø F	G	Ø Duct
XM-10	4	234	70	48	40	95	95	29	50/55
XM-20	6	300	70	50	40	105	105	29	50/55
XM-30	9	362	100	64	43	130	130	29	65/70
XM-35	12	493	113	74	48	155	155	29	75/80
XM-40	18	629	113	74	62	180	180	29	80/85
XM-45	19	629	113	74	67	180	180	29	80/85
XM-50	22	693	130	84	69	195	195	29	90/95
XM-55	25	742	150	98	67	215	215	29	100/105
XM-60	27	749	150	98	76	220	220	29	100/105
XM-70	31	913	150	98	74	245	245	29	100/105
XM-75	37	1001	175	113	80	265	265	29	115/120
XM-80	40	1001	175	113	84	270	270	29	115/120
XM-90	46	1118	190	123	87	295	295	29	125/130
XM-95	51	1079	210	138	97	305	305	29	140/145
XM-100	55	1089	210	138	98	310	310	29	140/145

All dimensions in mm



It should be noted that dead end (DE) anchorages are designed to be exposed passive ends. If they are to be buried, provision should be made to seal the wedges with a grout cap or similar to prevent concrete ingress.

Buried Dead End

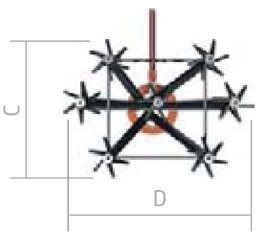


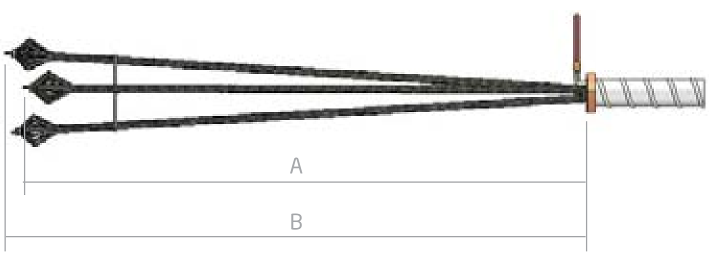
15mm Tendons									
Anchorage	No. of Strands	A	B	Ø C	D	Ø E	Ø F	G	Ø Duct
XM-10	3	234	70	48	45	95	95	29	50/55
XM-20	4	300	70	50	45	105	105	29	50/55
XM-30	7	362	100	64	48	130	130	29	65/70
XM-35	9	493	113	74	47	155	155	29	75/80
XM-40	12	629	113	74	54	180	180	29	80/85
XM-45	13	629	113	74	63	180	180	29	80/85
XM-50	15	693	130	84	60	195	195	29	90/95
XM-55	17	742	150	98	62	215	215	29	100/105
XM-60	19	749	150	98	76	220	220	29	100/105
XM-70	22	913	150	98	70	245	245	29	100/105
XM-75	25	1001	175	113	80	265	265	29	115/120
XM-80	27	1001	175	113	83	270	270	29	115/120
XM-90	31	1118	190	123	94	295	295	29	125/130
XM-95	35	1079	210	138	94	305	305	29	140/145
XM-100	37	1089	210	138	102	310	310	29	140/145

All dimensions in mm

XM basket dead end anchorages...

Basket dead end anchorages can be used in place of standard dead end anchorages. The pre-stressing force is transferred to the concrete by bond. A rebar net is required to act as a spacer for the individual strands. Basket dead ends are constructed on site using an extrusion rig.





Anchorage	No. of Strands	A	B	C	D	Ø Duct
XM-10	3	-	1300	220	220	50/55
XM-20	4	-	1300	220	220	50/55
XM-30	7	1150	1300	220	340	65/70
XM-35	9	1150	1300	220	340	75/80
XM-40	12	1150	1300	280	340	80/85
XM-45	13	1150	1300	280	460	80/85
XM-50	15	1150	1300	280	460	90/85
XM-55	17	1150	1300	340	460	100/105
XM-60	19	1150	1300	340	460	100/105
XM-70	22	1150	1300	340	580	100/105
XM-75	25	1150	1300	340	580	115/120
XM-80	27	1300	1450	340	700	115/120
XM-90	31	1300	1450	400	700	125/130
XM-95	35	1625	1775	400	700	140/145
XM-100	37	1625	1775	400	700	140/145

All dimensions in mm

XM dead end anchorages...

Compression Fitted Dead End Anchorage

CCL Dead End Anchorages are used where the end of a pre-stressing cable is buried in concrete or is inaccessible during the stressing of the tendon. The dead end anchor can accept the same strand configurations as the standard anchor and uses the same tube unit to guide the strands. The strand passes through a parallel hole bearing plate and is anchored by means of a compression fitting, which is swaged onto the strand ensuring a positive anchor using a CCL Extrusion Rig activated by a hydraulic pump. A retaining plate is fixed onto studs in the four tapped holes of the tube unit to ensure that the compression fittings bear evenly on the bearing plate.

XM Plate Dead End Anchorage

CCL XM Dead End Anchorages are used where pre-stressing force is required immediately behind the anchorages in inaccessible locations. The anchors are made by threading plates onto the strands and swaging compression fittings to hold the plates in place. A shorter length of strand is required to develop full pre-stressing force.

XM Loop Dead End Anchorage

A further alternative for a dead end in inaccessible locations is the CCL Loop Dead End Anchorage. These are used in slabs, bridges, tanks and in vertically post-tensioned elements in walls and piers. The duct is placed in the formwork prior to concreting and the strands are installed after casting of the concrete. Both ends of the strands are stressed simultaneously.

XM Loop Dead End Anchorage

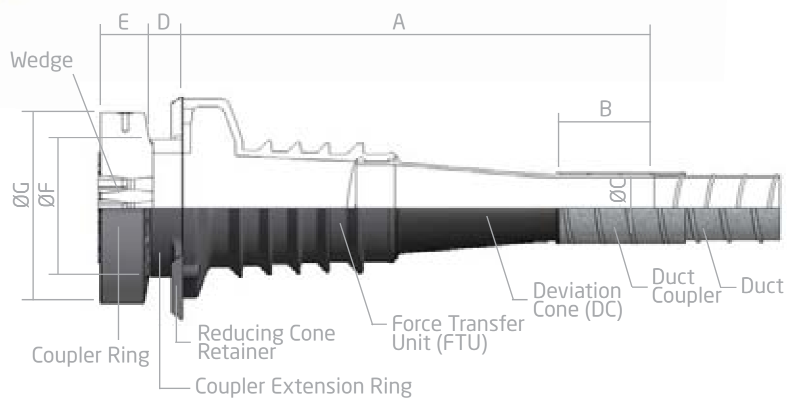
Anchor	No of strands	Straight Duct		Loop Duct		R Min mm
		Ø Inside mm	Ø Outside mm	Ø Inside mm	Ø Outside mm	
XM-10	4	50	55	50	55	600
XM-20	6	50	55	60	65	720
XM-30	9	60	65	70	75	840
XM-35	12	75	80	80	85	960
XM-40	18	75	80	95	100	1140
XM-45	19	75	80	95	100	1140
XM-50	27	100	105	120	125	1440

XM coupler anchorage...

XM Coupler

In continuous bridge deck construction, it is necessary to extend pre-stressing cables as construction proceeds. The first stage of stressing is carried out in the same way as with the standard anchor except that a coupler ring replaces the anchor head.

When first stage stressing and grouting is complete, the second stage strands are threaded into the wedges. The strand is deviated through a shaped trumpet that also prevents the ingress of concrete during casting.



Anchorage	No. of Strands	A	B	Ø C	D	E	Ø F	Ø G	Ø Duct
XM-10	3	234	70	48	46	60	100	185	50/55
XM-20	4	300	70	50	46	60	110	195	50/55
XM-30	7	362	100	64	46	60	135	220	65/70
XM-35	9	493	113	74	46	60	160	245	75/80
XM-40	12	629	113	74	46	69	180	265	80/85
XM-45	13	629	113	74	46	71	180	265	80/85
XM-50	15	693	130	84	46	75	200	285	90/95
XM-55	17	742	150	98	46	77	215	300	100/105
XM-60	19	749	150	98	46	84	220	305	100/105
XM-70	22	913	150	98	46	86	240	325	100/105
XM-75	25	1001	175	113	46	92	265	350	115/120
XM-80	27	1001	175	113	46	96	265	375	115/120
XM-90	31	1118	190	123	46	109	290	410	125/130
XM-95	35	1079	210	138	46	112	305	430	140/145
XM-100	37	1089	210	138	46	116	305	435	140/145

All dimensions in mm

coupler anchorages...

Compression Fitting Couplers

As an alternative to the standard coupler using wedges, a system with compression fittings can be provided. In addition to the standard live end (LE) anchor it incorporates a cast coupler ring. which is inserted between the anchor head (AH) and the force transfer unit (FTU). The coupler ring incorporates slots to accommodate the compression fittings swaged to the strands of the second stage cable using an extrusion rig. The strand is deviated through a shaped trumpet that also prevents the ingress of concrete during casting. The trumpet contains a grout exit point which should be placed at the top to prevent any air being trapped during grouting. The small end of the trumpet should be securely taped to the duct.

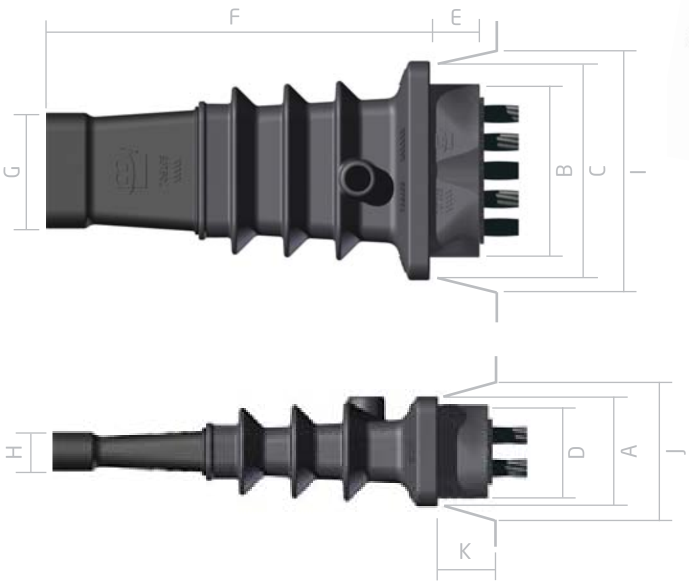
Moveable Couplers

Moveable Couplers use a special double ended joint (DEJ) to connect the second stage of the tendon to the first. The special DEJs are extremely slim and use internal wedges to grip the strand. Unique safety pegs are used to ensure that the wedges grip the strand securely when fitting. The moveable couplers are staggered to allow for a very compact section. The assembly is contained within a steel or High-Density Polyethylene (HDPE) shroud. The DEJs can also be used to couple monostrands, tendons or single strands within a tendon.

XF live end anchorages...

CCL Bonded Flat System

It is possible to use XF anchorages with a number of strands fewer than the maximum number specified. In this case, strands are omitted from the standard anchor head.



13mm XF Dimensions

Anchorage	No. of Strands	A	B	C	D	E*	F	G	H	I	J	K
XF-10-3-13	3	80	90	108	66	38	242	56	33	126	98	102
XF-20-5-13	5	95	125	155	80	38	300	83	33	167	112	102
XF-30-6-13	6	95	150	190	80	38	332	100	33	202	112	102

15mm XF Dimensions

Anchorage	No. of Strands	A	B	C	D	E*	F	G	H	I	J	K
XF-10-2-15	2	80	90	108	66	43	242	56	33	126	98	102
XF-20-4-15	4	95	125	155	80	43	300	83	33	167	112	102
XF-30-5-15	5	95	150	190	80	43	332	100	33	202	112	102

All dimensions in mm
* Dimension E is for reference, the amount the anchor head protrudes from the force transfer unit (FTU).
Overall thicknesses of 13mm and 15mm Anchor Heads are 40 and 45mm respectively.
It can be noted that the 13mm and 15mm systems share the same FTU and deviation cone so are fully interchangeable. Only the anchor heads differ to suit 13mm or 15mm wedges. The wedges are available in three different sizes; 13mm, 15.2mm and 15.7mm.
Special 13mm wedges in 15mm form to allow 15mm systems to be used with 13mm strand are also available.

XF live end anchorages...

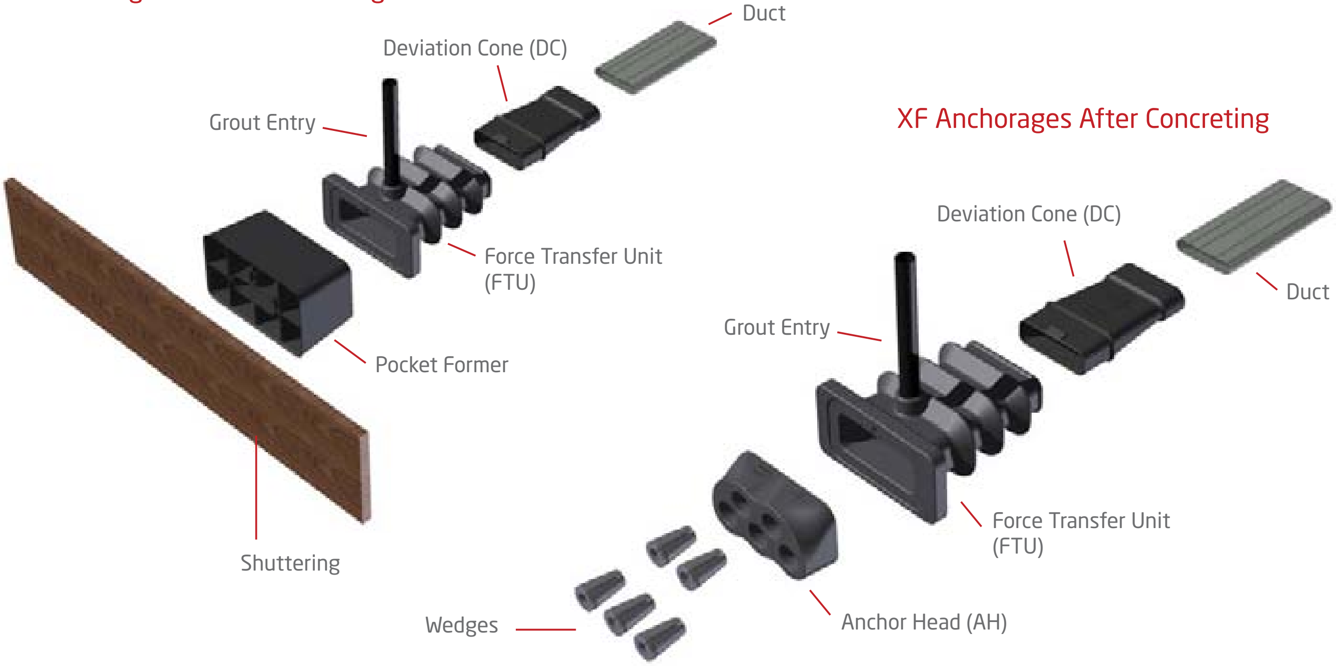
The CCL XF Anchorage is a flat system used mainly in slabs and transverse bridge structures. It can also be used in transfer beams, tanks and other civil structures and for both 13mm and 15mm tensile elements. The system connects bare strands which run through a steel or plastic flat oval duct. The strands are stressed individually using a Monostrand Jack.

The type of anchorage is designated by type and size in the following order:

XF	-	20	-	5	-	13
System Type		Anchorage Size		Maximum No. of Strands		Nominal Diameter

XF Anchorages Before Concreting

XF Anchorages After Concreting



13mm XF Flat Slab Anchorages

Anchorage	No. of Strands	Anchor Weight Kg	Duct Size mm	Duct Area mm^2	FTU Part No	Anchor Head Part No	Deviation Cone Part No	Pocket Former Part No
XF-10-3-13	3	3.58	19 x 43	736	706002	707203	706102	706312
XF-20-5-13	5	6.67	19 x 70	1257	706004	707205	706104	706314
XF-30-6-13	6	8.69	19 x 90	1580	706005	707206	706105	706315

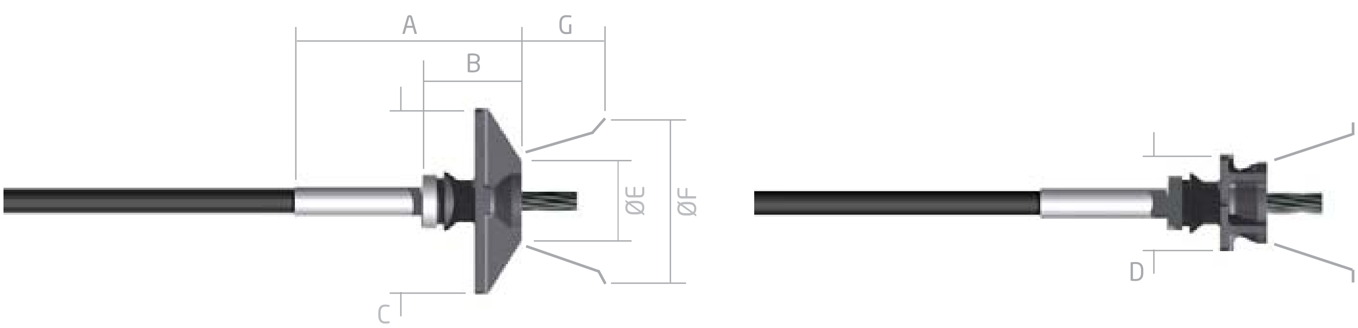
15mm XF Flat Slab Anchorages

Anchorage	No. of Strands	Anchor Weight Kg	Duct Size mm	Duct Area mm^2	FTU Part No	Anchor Head Part No	Deviation Cone Part No	Pocket Former Part No
XF-10-2-15	2	3.79	19 x 43	736	706002	707002	706102	706312
XF-20-4-15	4	6.89	19 x 70	1257	706004	707004	706104	706314
XF-30-5-15	5	8.97	19 x 90	1580	706005	707005	706105	706315

XU anchorages...

XU Live End Anchorages

The CCL Unbonded System is designed to work with both 13mm and 15mm nominal diameter strands. On completion of the stressing, the strand is cropped and the strand end and wedges are sealed with a grease filled plastic cap.



XU Live End Dimensions							
Anchorage	A	B	C	D	Ø E	Ø F	G
XU-13	153	73	110	63	62	106	62
XU-15	184	81	150	78	65	106	62

All dimensions in mm

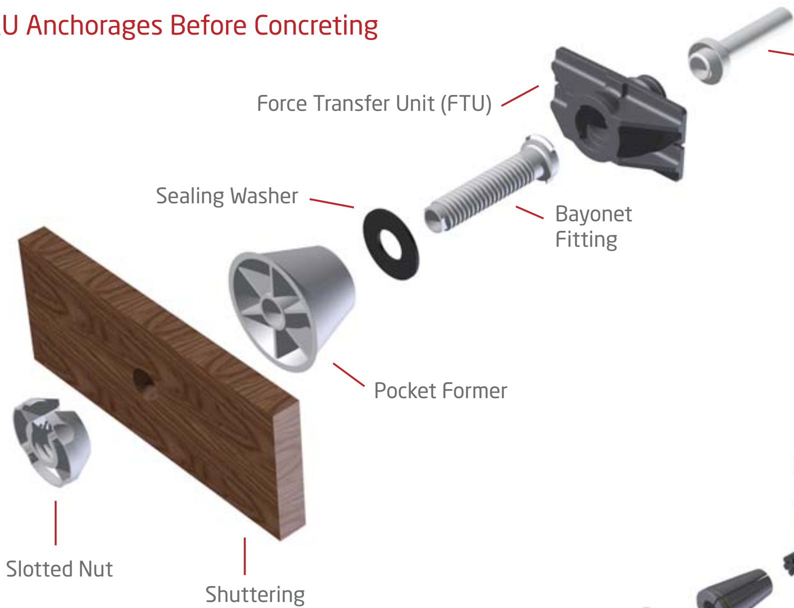
The wedges are available in three different sizes; 13mm, 15.2mm and 15.7mm.

Special 13mm wedges in 15mm form to allow 15mm systems to be used with 13mm strand are also available.

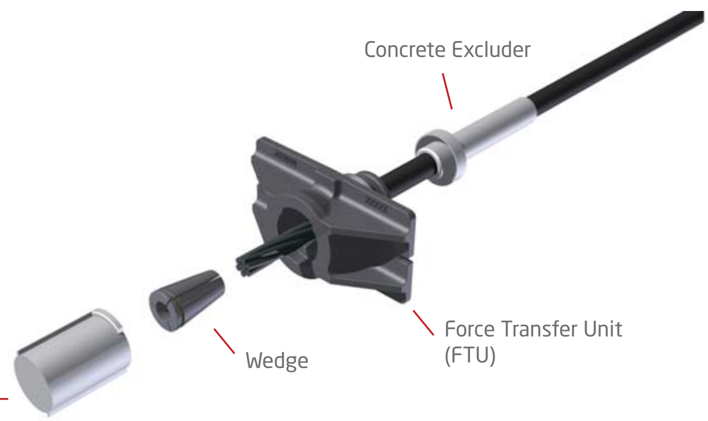
XU anchorages...

The CCL XU System is a monostrand system mainly used in slabs. It can also be used in tanks and remedial applications. The anchorages can be used for both 13mm and 15mm tensile elements. The system connects to unbonded strands, therefore eliminating the need for duct. In some cases, the system is used as a monostrand bonded or as a dead end system on multi strand applications. The strands are stressed individually using a monostrand Jack.

XU Anchorages Before Concreting



XU Anchorages After Concreting



XU Live End Anchorage				
Anchorage	**Anchor Weight Kg**	**FTU Part No.**	**Concrete Excluder Part No.**	**Sealing Cap Part No.**
XU-13	0.88	709210	709220	709070
XU-15	1.53	709010	709020	709070

XU Anchorages Reusable Accessories				
Anchorage	**Pocket Former Part No.**	**Slotted Nut Part No.**	**Bayonet Fitting Part No.**	**Sealing Washer Part No.**
XU-13	709030	709040	709050	709060
XU-15	709030	709040	709050	709060

tank anchorages...

Anchorage XT

These anchors are predominately used on circular structures such as tanks, reservoirs, silos etc. and are stressed using monostrand Jacks. The design allows the tendon to anchor the live end of the anchorage against the passive end, so acting also as a coupler anchorage. The body of the item is cast in a single unit to provide a compact self-contained anchorage.

external post-tensioning...

External post-tensioning is an increasingly popular method of strengthening both new and existing structures. External post-tensioning can extend the life of old structures including bridges, car parks, factories and residential buildings and is a highly cost-effective alternative to traditional internal post-tensioning in new structures.

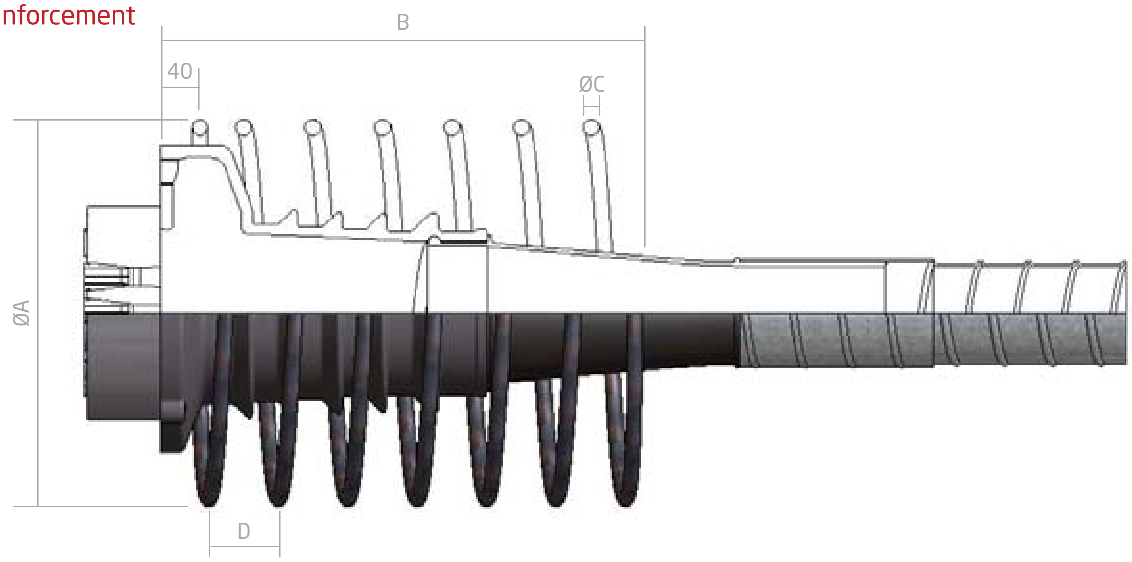
In response to requirements to inspect and or replace tendons, an external post-tensioning system can be used.

External tendons reduce congestion in concrete and offer a high degree of corrosion resistance whilst allowing inspection and in some cases replacement. Friction losses are also kept to a minimum as they only occur at the deviators and anchorage points.

Deviators at intermediate points normally take the form of steel pipes curved to a radius.

reinforcement...

Bursting Reinforcement



Helical reinforcement fyk=500MPa*

	Concrete Strength at Transfer $f_{cm,0}$ (MPa)														
	C25/30**					C35/45**					C45/55**				
Anchorage	Ø A	B	Ø C	D	N	Ø A	B	Ø C	D	N	Ø A	B	Ø C	D	N
XM-10	195	245	10	40	5.5	195	245	8	45	5.0	195	245	8	45	5.0
XM-20	235	285	10	45	5.5	220	270	10	50	5.0	205	255	10	55	4.0
XM-30	290	340	12	40	8.0	270	320	12	40	7.5	250	300	12	40	7.0
XM-35	335	385	12	40	9.0	320	370	12	45	7.5	305	355	12	50	6.5
XM-40	390	440	12	40	10.5	370	420	12	45	8.5	350	400	12	50	7.5
XM-45	415	465	12	40	11.0	385	435	12	40	10.0	355	405	12	45	8.5
XM-50	450	500	16	60	8.0	410	460	12	40	11.0	365	415	12	40	9.5
XM-55	475	525	16	55	9.0	430	480	16	60	7.5	385	435	16	50	8.0
XM-60	500	550	16	55	9.5	455	505	16	55	8.5	410	460	16	50	8.5
XM-70	540	600	16	55	10.5	485	545	16	55	9.5	430	490	16	50	9.5
XM-75	580	640	16	50	12.5	520	580	16	50	11.0	460	520	16	50	10.0
XM-80	605	665	20	70	9.0	540	600	16	50	11.5	470	530	16	50	10.0
XM-90	670	730	20	70	10.0	590	650	16	50	12.5	510	570	16	50	11.0
XM-95	690	760	20	65	11.5	610	680	16	45	14.5	530	600	16	45	12.5
XM-100	700	770	20	60	12.5	625	695	16	45	15.0	550	620	16	45	13.0

All dimensions in mm

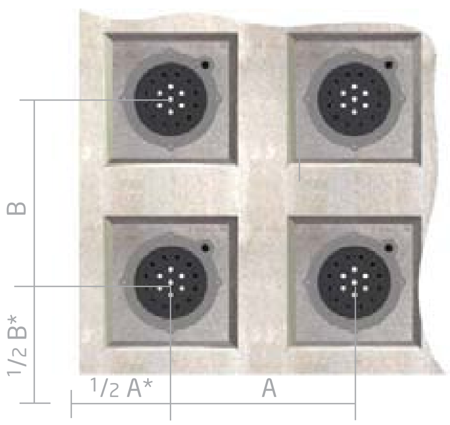
**Concrete strengths shown are cylinder test strength/cube test strength.

N= No. of turns in Helix

anchorage positioning...

The positioning of ducts and anchorages should be set out taking into account the dimensions shown below. The concrete strength and required pre-stressing will affect the anchorage centres.

Other configurations are also available to suit specific requirements.



*Subject to local reinforcement cover requirements

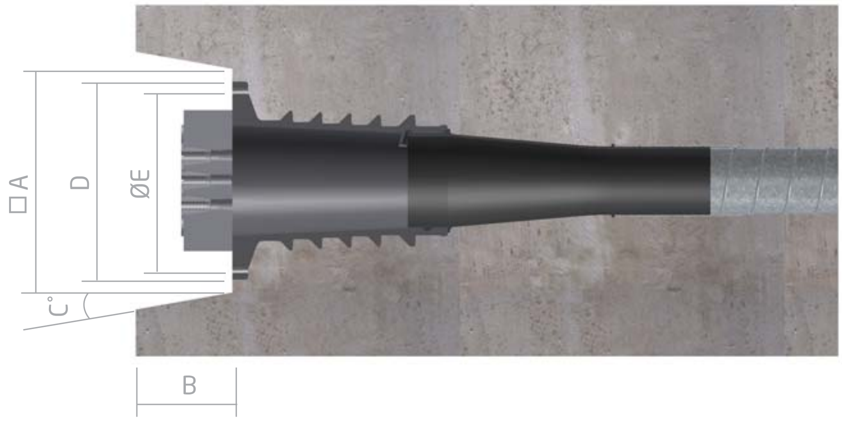
	Concrete Strength at Transfer $f_{cm,0}$ (MPa)					
	C25/30**		C35/45**		C45/55**	
Anchorage	A	B	A	B	A	B
XM-10	245	245	245	245	245	245
XM-20	285	285	270	270	255	255
XM-30	340	340	320	320	300	300
XM-35	385	385	370	370	355	355
XM-40	440	440	420	420	400	400
XM-45	465	465	435	435	405	405
XM-50	500	500	460	460	415	415
XM-55	525	525	480	480	435	435
XM-60	550	550	505	505	460	460
XM-70	600	600	545	545	490	490
XM-75	640	640	580	580	520	520
XM-80	665	665	600	600	530	530
XM-90	730	730	650	650	570	570
XM-95	760	760	680	680	600	600
XM-100	770	770	695	695	620	620

All dimensions in mm

**Concrete strengths shown are cylinder test strength/cube test strength.

For values of $f_{cm,0}$ between C25/30 and C45/55, A and B can be determined by straight line interpolation. The mean compressive strength of concrete at which full pre-stressing is permitted, $f_{cm,0}$ specified by the designer of the structure must be greater than or equal to C25/30. In the case of partial stressing of a standard anchorage to 50% of Fpk, the minimum mean compressive strength of concrete could be reduced by 30%. The table above is based on the requirements of ETAG 013 and typical concrete strengths. For CCL recommendation and full design rules outside the above please contact CCL for advice. Refer to Design Rules. Other types of configuration are available please contact CCLfor further details.

stressing pockets...



Anchorage	No. of strands 13mm	No. of strands 15mm	A	B	C°	D	Ø E
XM-10	4	3	200	120	20	152	130
XM-20	6	4	200	120	20	162	140
XM-30	9	7	230	123	10	192	168
XM-30	9	7	260	123	10	192	168
XM-35	12	9	280	123	10	240	210
XM-40	18	12	305	137	10	266	236
XM-45	19	13	305	142	10	266	236
XM-40	18	12	330	137	10	266	236
XM-45	19	13	330	142	10	266	236
XM-50	22	15	340	144	10	283	253
XM-55	25	17	340	142	10	300	270
XM-60	27	19	350	151	10	310	280
XM-50	22	15	405	144	10	283	253
XM-55	25	17	405	142	10	300	270
XM-60	27	19	405	151	10	310	280
XM-70	31	22	405	149	10	365	325
XM-75	37	25	405	155	10	375	335
XM-80	40	27	405	159	10	390	350
XM-60	27	19	475	151	10	310	280
XM-70	31	22	475	149	10	365	325
XM-75	37	25	475	155	10	375	335
XM-80	40	27	475	159	10	390	350
XM-90	46	31	475	169	10	418	378
XM-95	51	35	475	172	10	436	396
XM-100	55	37	475	177	10	436	396

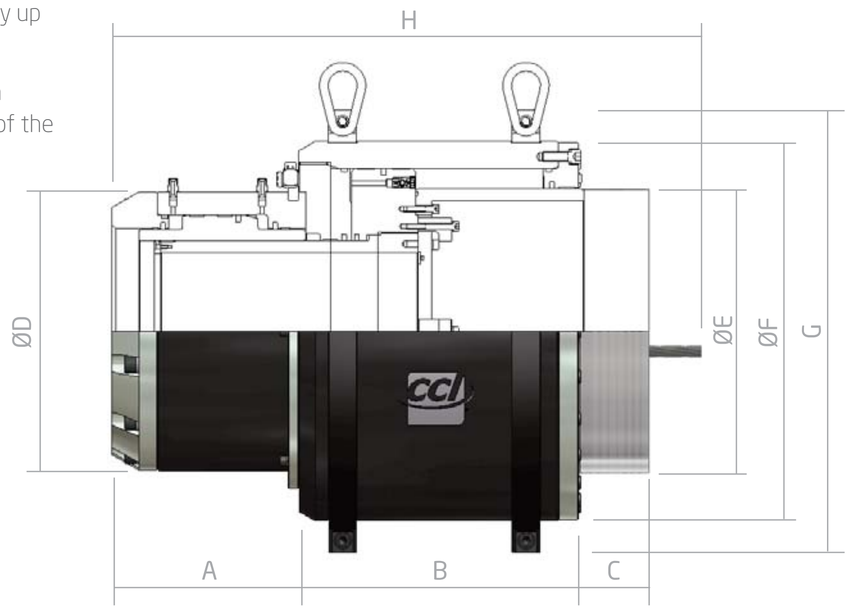
All dimensions in mm except where stated.

jack sizes...

CCL Jacks are simple to operate and easy to manoeuvre. The jack body can be rotated around its lifting points, enabling easy access to hydraulic connections. The jack innards can also be rotated, promoting easy alignment with the tendons. The jacks may be operated in a vertical or horizontal position and feature hydraulic lock-off. This is to ensure the correct seating of the wedges and to minimise load losses at transfer.

The CCL MG Stressing Jacks used for the CCL XM System have the following features:

- Automatic gripping of the wedges on the strands
- Simultaneous stressing of all the strands of the tendon
- Support of the jack on the FTU, by means of a temporary bearing ring
- Simultaneous hydraulic lock-off of all the wedges in the anchor head
- Partial stressing of the tendons with later recovery up to the final values of the pre-stressing force
- Stressing by successive loadings of the jack when the final extension is greater than the full stroke of the CCL Jack
- Different jack innards requirement for each system size



MG Jack Dimensions

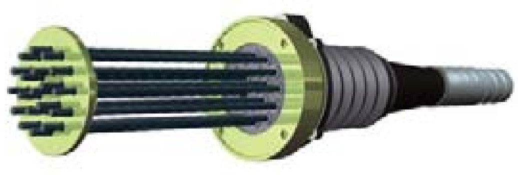
Jack Size	A	B	C*	Ø D	Ø E	Ø F	G	H** min	Weight
1800MG	322	388	218	256	232	342	432	711	275kg
3000MG	290	388	200	280	270	405	500	684	350kg
4000MG	307	415	220	344	360	490	585	722	575kg
6000MG	304	462	209	386	410	576	680	766	700kg
7500MG	321	480	220	478	490	652	760	801	1150kg

All dimensions in mm
* Stroke of jack
** Minimum length of strand

stressing...

CCL Stressing Sequence

1. Place the bearing plate onto the strands, ensuring that the centre mark is at the top. Fit the wedges into the anchor head, then fit the bearing ring and lock-off plate.



2. Thread the jack onto the strands. A suitable lifting device should support the weight of the jack.

3. Push the jack up to the anchorage and insert the jack wedges into the pulling plate inside the rear of the jack.

4. All stressing operations are controlled from the pump unit to ensure the operator's safety. Carry out stressing, lock-off and retraction. The lock-off pushes the lock-off plate forward, which seats the anchorage wedges firmly into the anchor head.

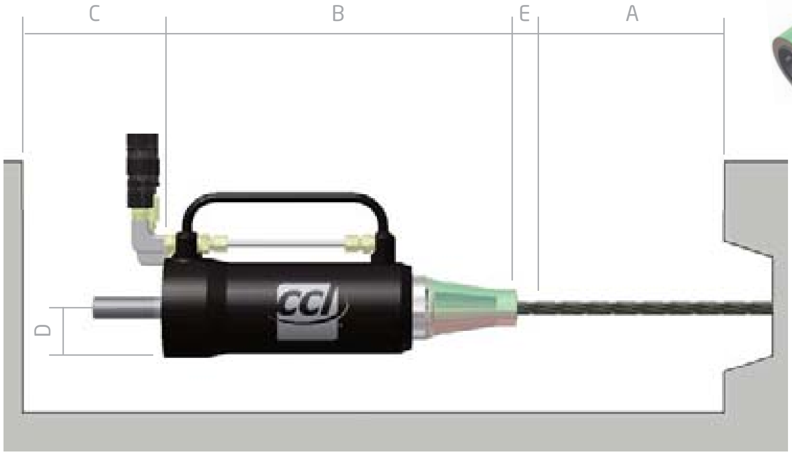
Jack Selection Table

Anchorage	No. of Strands 13mm	No. of Strands 15mm	1800MG	3000MG	4000MG	6000MG	7500MG
XM-10	4	3	●				
XM-20	6	4	●				
XM-30	9	7	●	●			
XM-35	12	9		●			
XM-40	18	12		●	●		
XM-45	19	13		●	●		
XM-50	22	15			●	●	
XM-55	25	17			●	●	
XM-60	27	19			●	●	●
XM-70	31	22				●	●
XM-75	37	25				●	●
XM-80	40	27				●	●
XM-90	46	31					●
XM-95	51	35					●
XM-100	55	37					●

monostrand jacks...

Hollowram Jacks

The CCL Hollowram Jack is a compact lightweight jack specifically designed to stress the XF and XU Anchorages. The noses of the jacks can be changed to suit various applications. The type of jack for each application can be taken from the table below.



Hollowram Jack Clearance

Jack	Anchorage	Strand Ø	A	B	C	D	E Extension	Total Clearance
250kN	XF	13	220	415	100	70	190	925
250kN	XF	15	220	415	100	70	190	925
250kN	XU	13	175	370	100	70	190	835
250kN	XU	15	175	370	100	70	190	835

All dimensions in mm

Hollowram Jack Part Numbers

Jack	XU13	XU15	XF13	XF15
250kN HR Jack (Including Nose Assembly Plunger)	103100	103110	103101	103111
Jack Weight (Kg)	20.3	20.5	20.5	20.7
Swivel Nose Assembly	103026	103029	103020	103023

All jacks need to be calibrated to a pump before use. The jacks can be used for partial stressing and successive loading if necessary.

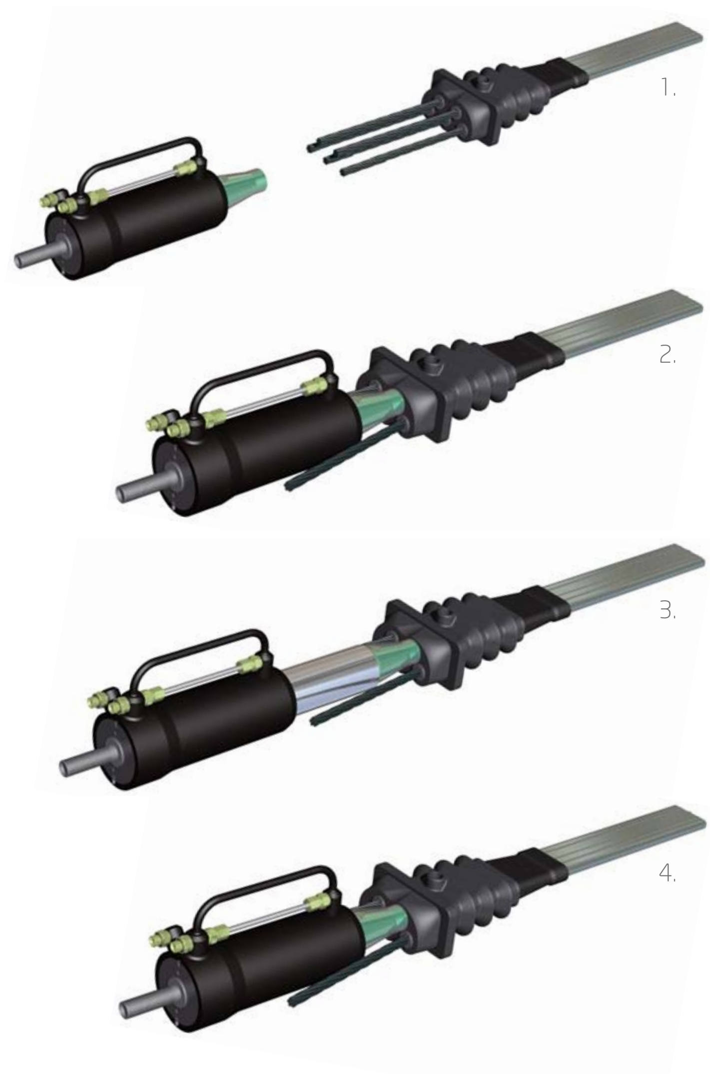
stressing sequence...

1. After removal of formwork the anchor head and wedges are threaded onto the strands.

2. Using the correct jack and nose combination with calibrated pump / gauge, the jack is threaded onto the strands and pushed up to the anchor head.

3. All stressing operations are controlled from the pump unit to ensure the operator's safety. The jack is extended and when the load is reached, the jack locks off which seats the anchorage wedges firmly into the anchor head.

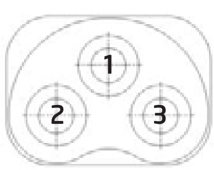
4. The jack is then retracted and the wedge released so the jack can be removed when the full load is reached or the operation can be repeated until the required load is achieved.



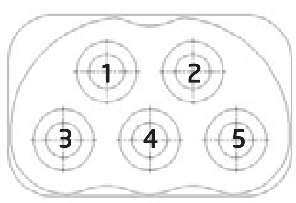
XF SEQUENCE

If missing out a strand it should be considered that the following should be omitted:

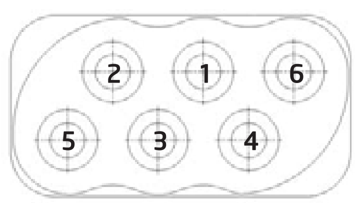
XF-10-3-13 Position 1
XF-20-5-13 Position 4
XF-30-6-13 Position 3
XF-10-2-15 Position 2
XF-20-4-15 Position 4
XF-30-5-15 Position 3



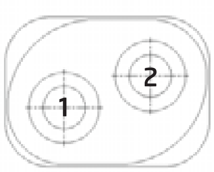
XF-10-3-13



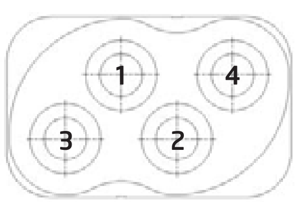
XF-20-5-13



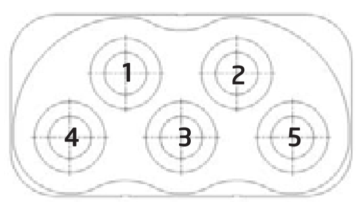
XF-30-6-13



XF-10-2-15



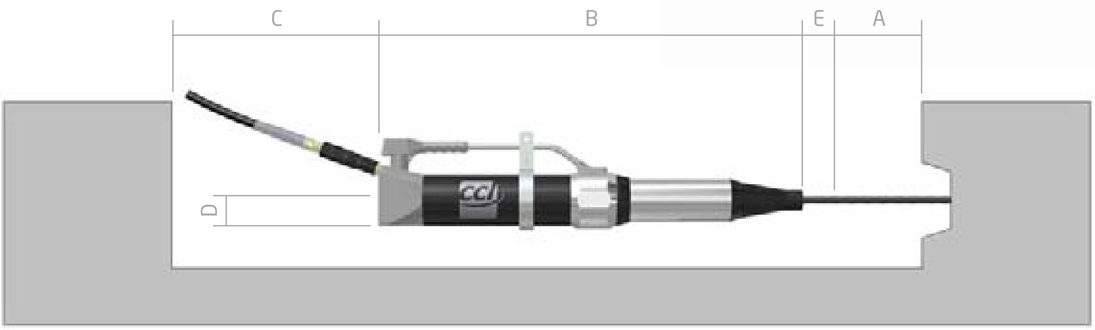
XF-20-4-15



XF-30-5-15

stressomatic jacks...

The primary items of equipment in the XF and XU operations are the CCL Stressing Jacks. The noses of the jacks can be changed to suit various applications and feature automatic gripping and lock-off on the strand. All jacks need to be calibrated to a pump before use. The jacks can be used for partial stressing and successsive loading if necessary. The type of jack for each application can be taken from the table below.



Stressomatic Jack Clearance

Jack	Stand Dia	A	B	C	D	E Extension	Total Clearance
160kN Short Stroke	13	225	755	200	60	205	1385
160kN Long Stroke	13	225	1085	200	60	535	2045
300kN Short Stroke	15	350	860	200	70	205	1615
300kN Long Stroke	15	350	1070	200	70	410	2030

All dimensions in mm

Stressomatic Jack Part Numbers

Jack	Weight Kg	XU13	XU15	XF13	E Extension
160kN Jack Short Stroke (Inc Nose Assembly Plunger)	28	106420	-	106421	-
160kN Jack Long Stroke (Inc Nose Assembly Plunger)	40	106430	-	106431	-
300kN Jack Short Stroke (Inc Nose Assembly Plunger)	48	-	107420	-	107421
300kN Jack Long Stroke (Inc Nose Assembly Plunger)	56	-	107430	-	107431

Specific noses are required to stress the XU or XF systems.

Stressomatic Jack Nose Part Numbers

Jack	XU13	XU15	XF13	XF15
160kN Jack Nose Assembly Plunger	106064/106063	-	106109	-
300kN Jack Nose Assembly Plunger	-	107048/107047	-	107122

CCL pump units...

CCL Pumps deliver multiple pressures to speed up the stressing operation while maintaining control for precise stressing when needed. Pumps can be supplied in various voltages with analogue or digital readouts.

SR5000 Pump

SR5000 pumps are heavy duty pumps to power MG Multistressing Jacks. They are specifically designed for site work and the high demands required to stress multiple strands simultaneously.

Pump	Weight Kg	Part Number
Multi Pump High Speed 415V 3Ph 50Hz	225	114005

SR3000 Pump

SR3000 pumps are of a robust design and come complete with a protective frame as standard. The high build quality and specifications of the parts used ensure high reliability and a low maintenance life for the unit.

Pump	Weight Kg	Part Number
SR3000 PT 110V 3Ph 50 Hz	125	170100
SR3000 PT 220/240V 3Ph 50Hz	125	170101
SR3000 PT 380/415V 3Ph 50Hz	125	170102

SRX Pump

SRX pumps are designed as a compact lightweight alternative to the SR3000 unit and are capable of delivering excellent performance on small strand diameters. Supplied in various voltages this pump is ideal for site work.

Pump	Weight Kg	Part Number
SRX Pump 110V 3Ph 50Hz with Analogue Gauge	62	171000
SRX Pump 220/240V 3Ph 60Hz with Analogue Gauge	62	171003
SRX Pump 415V 3Ph 50Hz with Analogue Gauge	62	171002

installing & grouting...

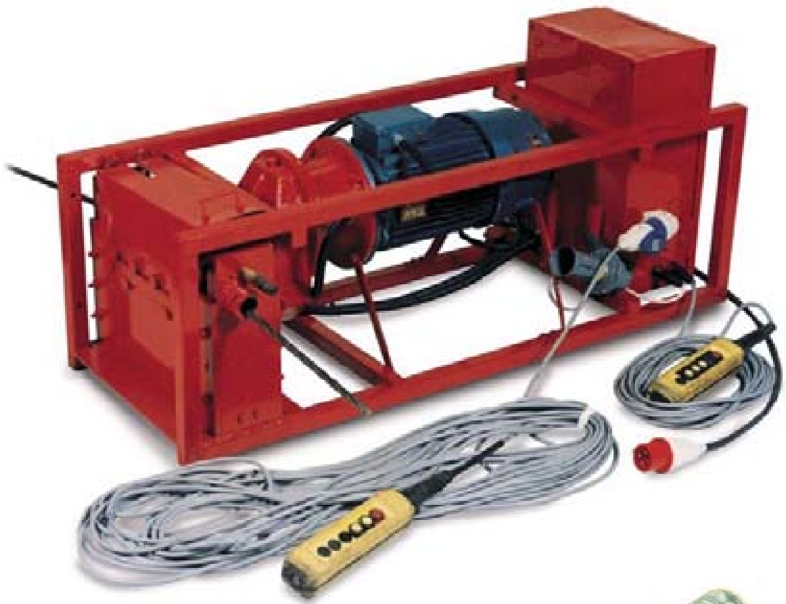
CCL Strand Installation

For internal pre-stressing the ducts are placed prior to concreting.

The strand is delivered to site in coils and placed in special dispensers to contain the coil and prevent it from uncoiling.

Before or after concreting, strands are pushed or winched into the duct from one end and cut to length. The installation method depends on the length of the tendon and access conditions.

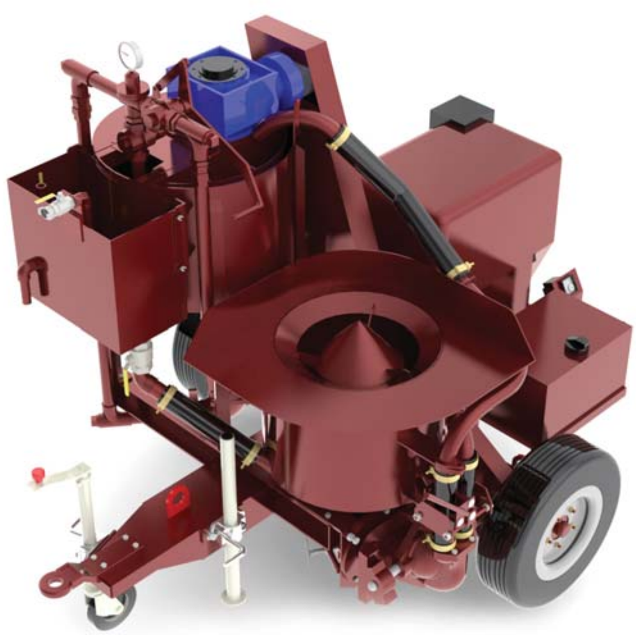
Special threading bullets are fixed to the leading end of the strand (in the case of pushing) to ease the passage of the strands through the duct. Using CCL Strand Pushers the pushing can be controlled from both ends of the tendon (using remote controls) ensuring a safe and efficient operation.



CCL Grouting

The durability of any post-tensioning is affected by the quality of the grouting operation. The grout, as well as providing a bond between the concrete and the tendon, provides long-term corrosion protection for the steel strand. If the grouting is not carefully controlled and undertaken by experienced professionals, it will compromise the structure and affect its lifespan.

Grouting is undertaken through the anchor using special threaded fittings and valves to ensure a clean and effective grouting operation. Intermediate vents are created along the tendon using grout saddles.



friction losses...

In post-tensioned concrete, the effect of friction between strands and sheathing during stressing is a major factor for loss of pre-stress.

There are three main causes of friction loss in the post-tensioned tendon:

- Friction due to the deviation of the tendon through the anchorage
- Friction between the tendon and the duct due to unintentional lack of alignment (or wobble) of the duct
- Friction due to the curvature of the duct

Friction loss in CCL XM anchorages determined from testing is 2-3%.

Wedge Set

After the transfer of load from the jack to the anchorage, the strand and wedges draw a little further into the anchor head. This further movement is known as wedge set or draw-in. The wedge set leads to a loss of tension in the strand which must be taken into account in the loss and elongation calculations. The value for wedge set to be used in the calculations for all active anchorages stressed with jacks with hydraulic lock-off is:

Wedge set = 6mm ± 2mm

Duct Friction Loss

Friction Loss in the duct for post-tensioned tendons can be estimated from:

$$\Delta P_{(x)} = P_{max}\left(1 - e^{-\mu(\theta + kx)}\right)$$

Where:

$\Delta P_{(x)}$ – Loss of force due to friction

P_{max} – Force at the active end during tensioning (after anchor losses)

θ – Sum of the angular displacements over a distance x (radians - irrespective of direction or sign)

μ – Coefficient of friction between strand and duct (1/radian)

k – Unintentional angular displacement (radians per unit length)

x – Distance along the tendon from the point where the pre-stressing force is equal to P_{max}

NOTE: Some design software and country codes use a term K or k = wobble or unintentional friction (per unit length). This is taken as K = x k, and the formulae is rearranged to suit.

The values for coefficient of friction and unintentional angular displacement k should be in line with EN 1992 Eurocode 2: Design of Concrete Structures, as shown in the table below.

Application	Duct Type	μ		*k*	
		Non Lubricated	Lubricated	Minimum	Maximum
Internal Pre-stressing	Corrugated Metal	0.19	0.17	0.005	0.01
	HDPE	0.12	0.10	0.005	0.01
	Steel Smooth Pipe	0.24	0.16	0.005	0.01
External Pre-stressing	HDPE	0.12	0.10	N/A	N/A
	Steel Smooth Pipe	0.24	0.16	N/A	N/A

When the tendon to be controlled has two Active / LE anchorages, i.e. with the tendon being able to be stressed with the jack at both ends, the measurement on site of the friction loss of the tendon is possible by comparing the load applied by one jack to the load measured on the other jack.

CCL helps you create unique structures. A focus on outstanding technical solutions, durable products and practical post completion advice has allowed CCL to deliver projects on an international basis for more than 30 years.

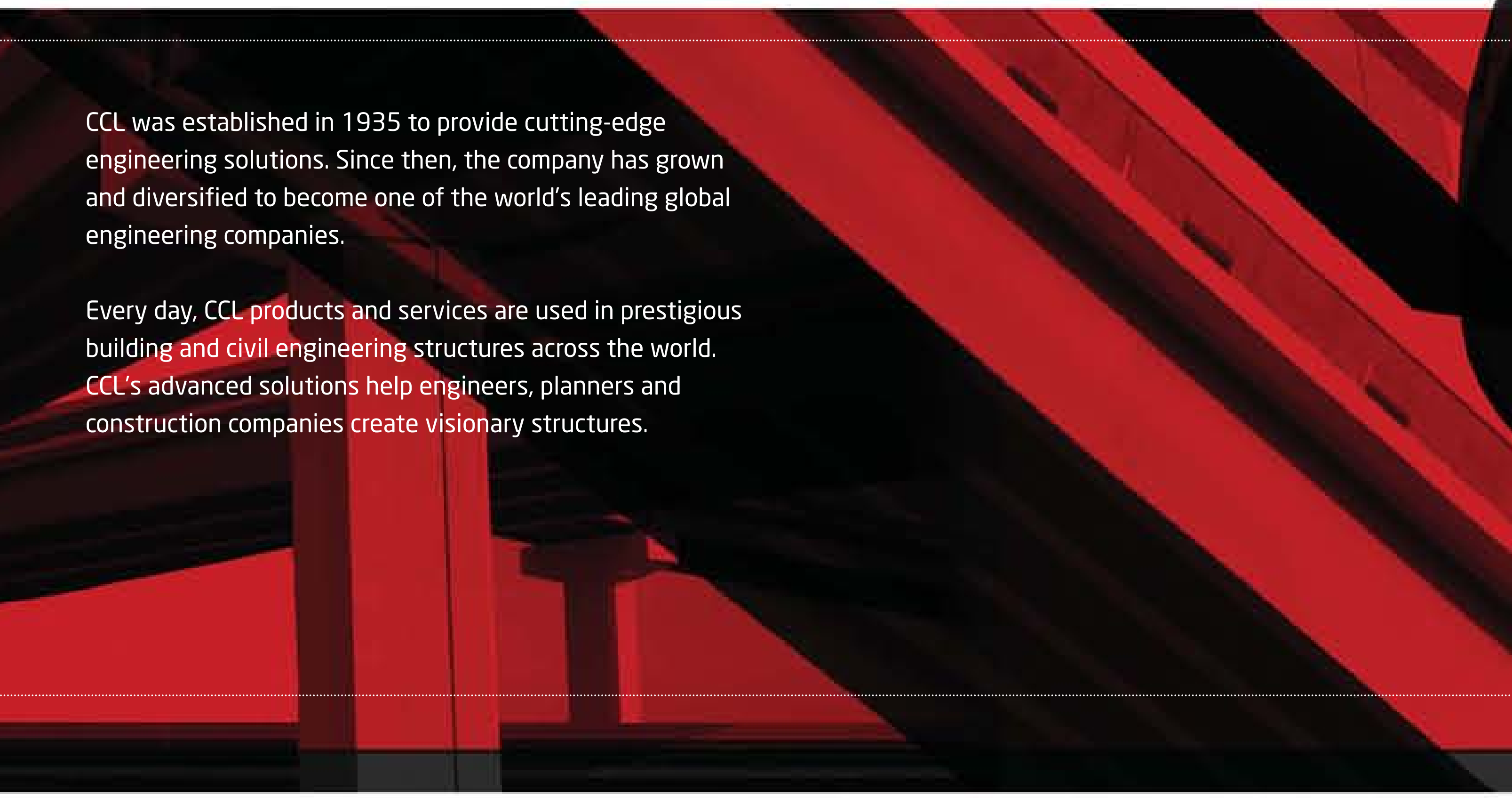
Quality Standards

CCL is an ISO registered company which operates a quality management system compliant with ISO9001 : 2008.

The company's high performance anchorage systems are designed manufactured and tested to exceed the latest European Standard ETAG 013.

CCL holds CARES approval for its post-tensioning systems.

All products are CE approved and certified.



CCL was established in 1935 to provide cutting-edge engineering solutions. Since then, the company has grown and diversified to become one of the world's leading global engineering companies.

Every day, CCL products and services are used in prestigious building and civil engineering structures across the world. CCL's advanced solutions help engineers, planners and construction companies create visionary structures.

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