

GROUND ANCHORS

ABOUT US

Since its establishment in 1991, STS has focused on design, manufacturing and enhancement of technologies, parts and equipment for the construction industry.

STS participated in the construction of over 700 projects; this experience facilitated the development of most efficient procedures and designs in terms of technology and equipment.



over **700** projects

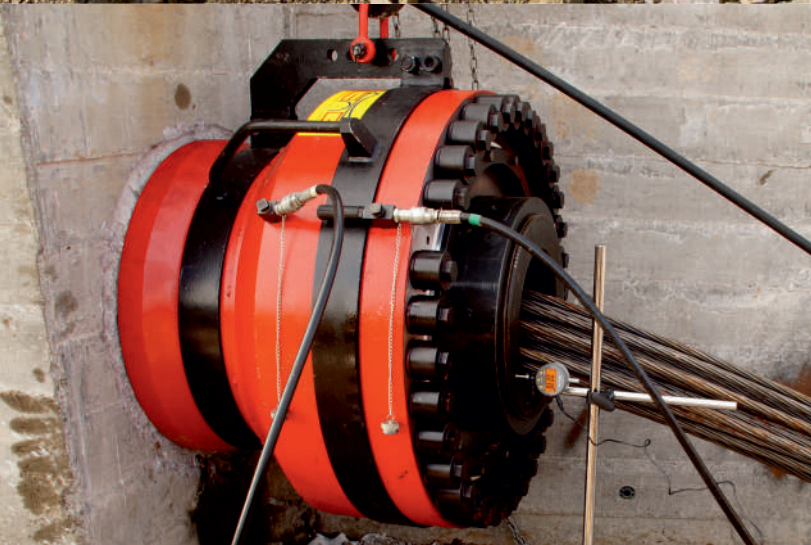
In the past few decades, ground anchors have been used a lot for construction of civil and transport projects. They are used to fix retaining walls and excavation pit sheeting, to stabilize slopes and hillsides.

Strand and injection bore anchoring systems are widely used.



Our company, together with Institute of Post-tensioning Technologies, designs and conducts structural analysis of all types of structures where ground anchors are used, and also renders supervision services.

Having a large fleet of machinery and equipment, we are able to manufacture and install ground anchors, carry out their grouting and tensioning.



TERMS AND DEFINITIONS



Temporary anchor AGP-V

ground anchor with a design life of max. two years.

Permanent anchor AGP-P

ground anchor with a design life equal to that of the anchored structure.

Removable anchor AGP-VI

temporary ground anchor with a removable anchor tendon.

Anchor head

anchor component that transfers load from the anchored structure or the soil onto the anchor tendon.

Anchor tendon

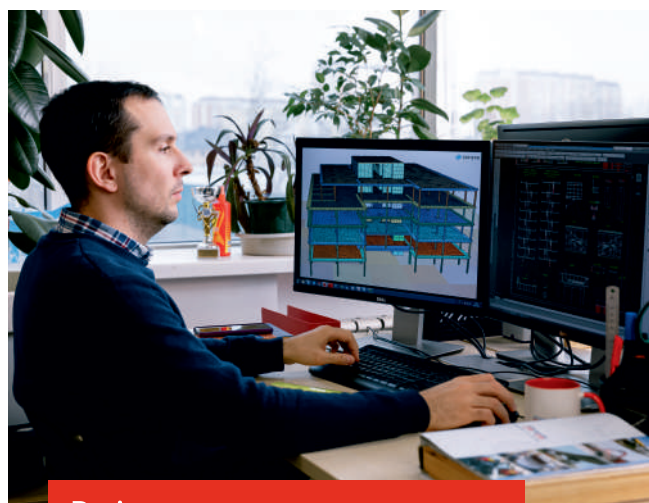
anchor component that transfers load from the anchor head onto the bond length.

Bond length

anchor component that transfers load from the anchor tendon onto the soil.

Design anchor load

most unfavorable combination of external loads acting on the anchored structure, taking into account the anchor tensioning.



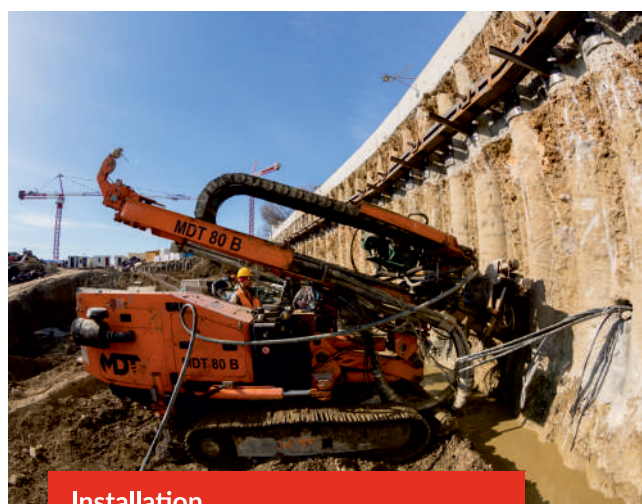
Design



Component manufacture



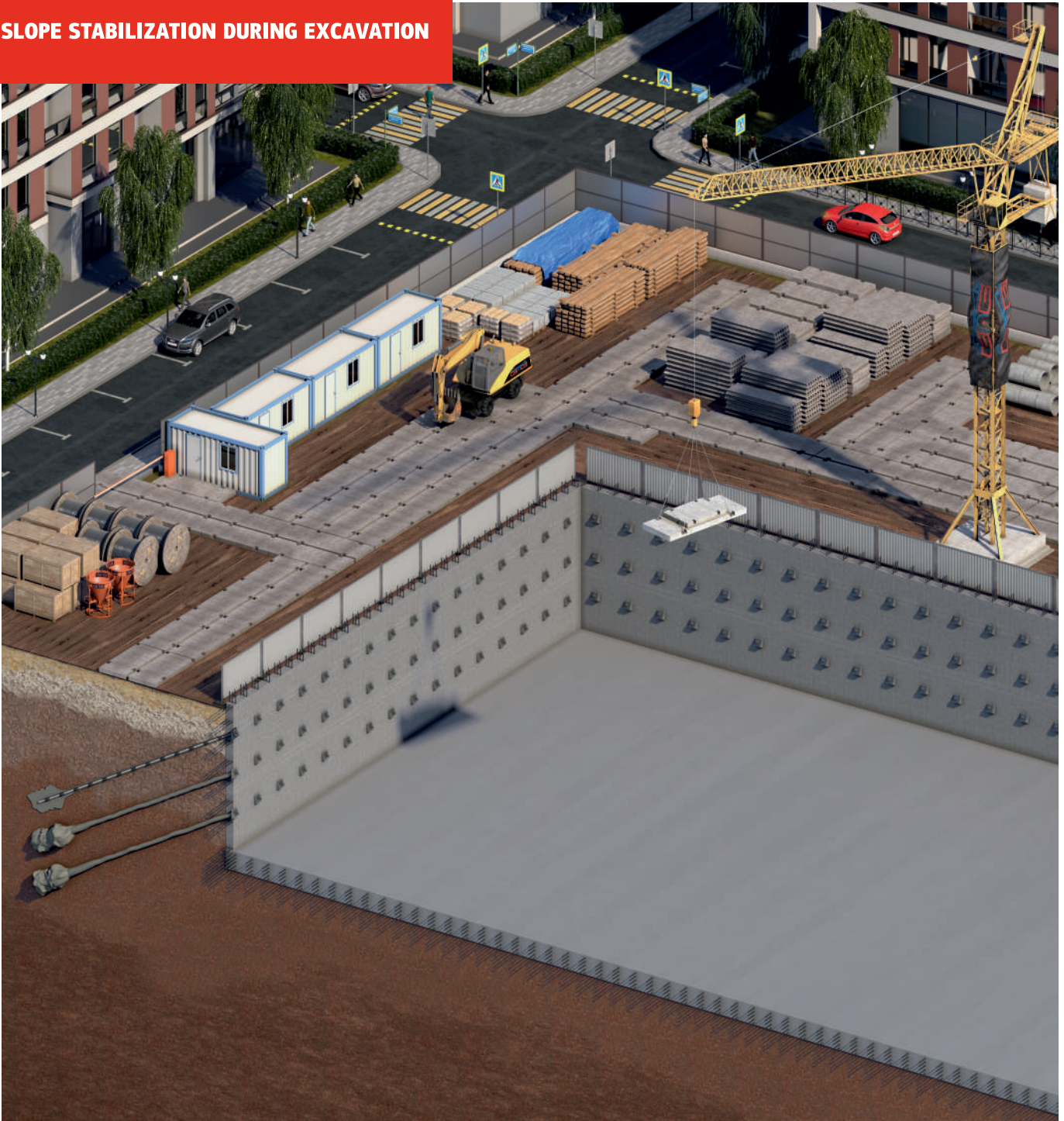
Assembly



Installation

APPLICATION

SLOPE STABILIZATION DURING EXCAVATION



Ground anchors supplied by STS showed good results in securing excavation pit sheeting, especially in cramped urban conditions. Compared to stabilization of excavation with struts, ground anchors supplied by STS provide for the following benefits:

- No major space requirement;
- High load capacity;

- Less time required to install excavation pit sheeting;
- Lower impact of construction on adjacent structures.

If required, ground anchors supplied by STS can be removed after the structure is completed.

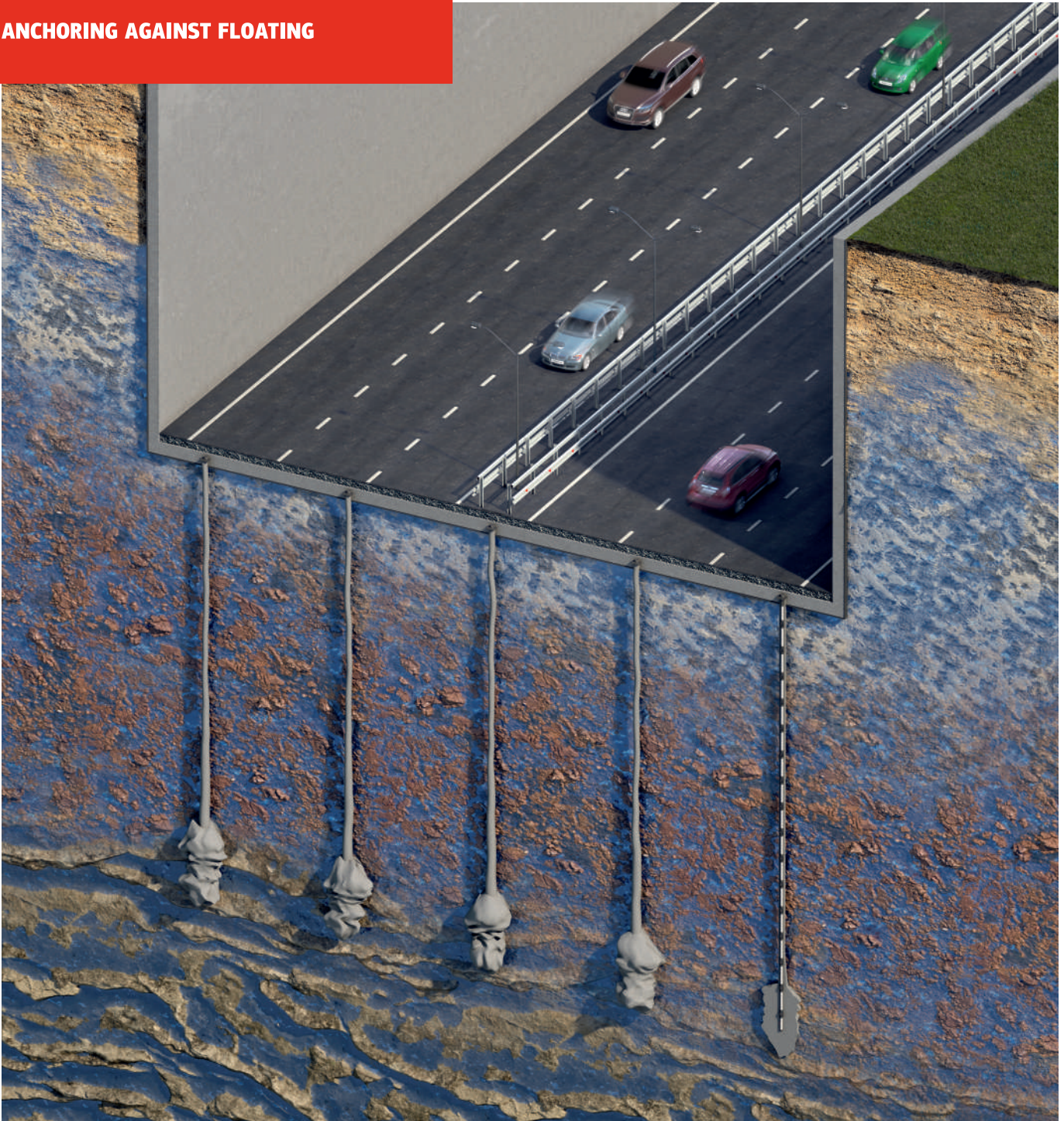
SECURING RETAINING WALLS



During construction or reconstruction of roads and railways in rugged and mountainous terrain, there is a requirement to ensure protection against potential landslides and rockfalls. As a solution, monolithic or prefabricated retaining walls can be used in combination with ground anchors supplied by STS. This structure

reinforces and retains unstable soil mass, thus protecting the transportation infrastructure from hazardous geological processes.

ANCHORING AGAINST FLOATING



In cases where the groundwater level is above the foundations of various buildings and structures, ground anchors supplied by STS can be used to prevent their floating up. They are used for such facilities as:

- Ramp sections of underwater tunnels;
- Docks and sinkholes;
- Foundations of wind power plants;
- Foundations of residential buildings, parking lots and business centers.

RE-STRENGTHENING OF BRIDGE ABUTMENTS



During a cable-stayed bridge life, pull-out forces can occur within its components, which can affect the stability of abutments in the soil mass, and, as a result, can be detrimental to the entire bridge structure safety.

One of the solutions is to reinforce the abutments with ground anchors supplied by STS, which can compensate for such pull-out forces.

SPECIFICATIONS

OF STRAND ANCHOR SUPPLIED BY STS

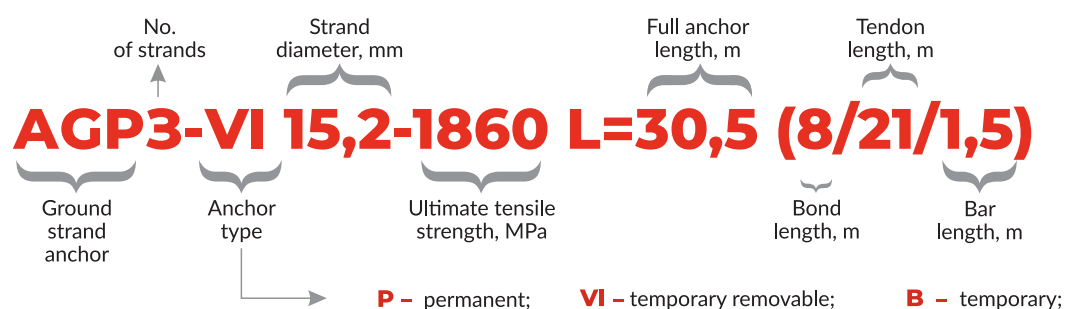
No. of strands in anchor, pcs.	Section size of anchor tendon, mm ²	Yield load capacity, kN	Minimum tensile strength, kN	Bearing load limit*, kN
Anchor specifications	15,2-1670			
1	139	204	232	105
2	278	408	464	210
3	417	612	696	315
4	556	816	928	420
5	695	1020	1160	525
6	834	1224	1392	629
7	973	1428	1624	734
8	1112	1632	1856	839
9	1251	1836	2088	944
Anchor specifications	15,2-1770			
1	139	216	246	111
2	278	432	492	222
3	417	648	738	333
4	556	864	984	444
5	695	1080	1230	555
6	834	1296	1476	667
7	973	1512	1722	778
8	1112	1728	1968	889
9	1251	1944	2214	1000
Anchor specifications	15,2-1860			
1	139	228	259	117
2	278	456	518	235
3	417	684	777	352
4	556	912	1036	469
5	695	1140	1295	586
6	834	1368	1554	704
7	973	1596	1813	821
8	1112	1824	2072	938
9	1251	2052	2331	1055
Anchor specifications	15,7-1770			
1	150	234	266	120
2	300	468	532	241
3	450	702	798	361
4	600	936	1064	481
5	750	1170	1330	602
6	900	1404	1596	722
7	1050	1638	1862	842
8	1200	1872	2128	963
9	1350	2106	2394	1083
Anchor specifications	15,7-1860			
1	150	246	279	127
2	300	492	558	253
3	450	738	837	380
4	600	984	1116	506
5	750	1230	1395	633
6	900	1476	1674	759
7	1050	1722	1953	886
8	1200	1968	2232	1012
9	1350	2214	2511	1139

Note: * - The bearing load limit based on the tendon strength during trials is equal to 0.9x proof stress. A designer shall also follow the relevant codes of practice for anchor load limits, depending on the anchor type: temporary or permanent anchor, type of facility: transport or civil engineering; but in any case, the rated bearing load shall not exceed the figures shown in the table.

DESCRIPTION AND MARKING



Strand ground anchor AGP0-V (VI; P) STO STS 003-2018

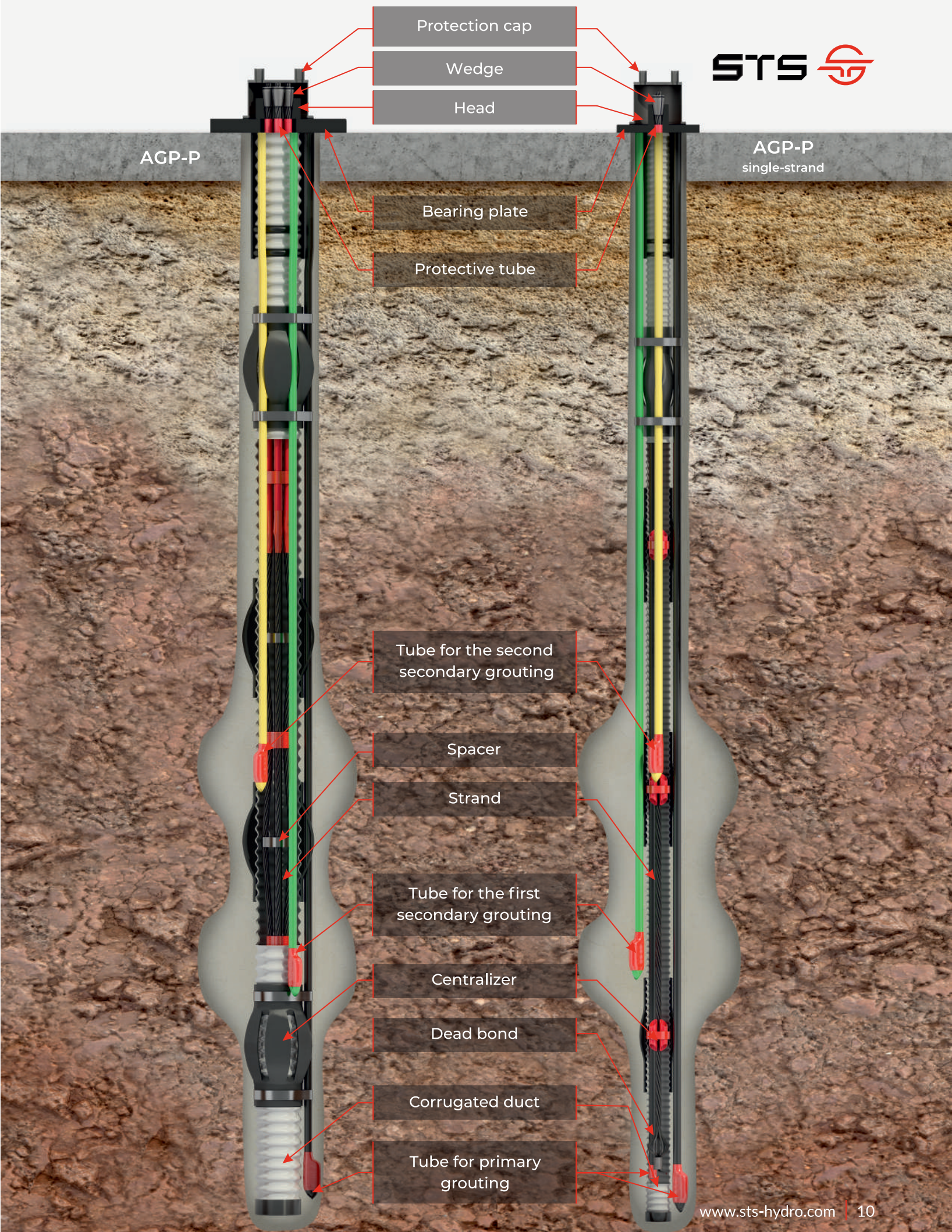


MAIN DIMENSIONS OF COMPONENTS

No. of strands, pcs.	Corrugated duct diameter, mm	Base plates AxHxT, mm	Anchor heads DxT, mm	min. Ø ID of casing tube, mm
AGP1-V	-	200x200x25	50x50	125
AGP2-V	-	260x260x30	110x51	125
AGP3-V	-	260x260x30	110x51	125
AGP4-V	-	260x260x40	110x51	125
AGP5-V	-	330x330x40	128x51	125
AGP6-V	-	330x330x50	128x51	132
AGP7-V	-	330x330x50	128x51	132
AGP8-V	-	370x370x50	150x65	132
AGP9-V	-	370x370x60	150x65	150
AGP1-P	63	200x200x25	50x50	125
AGP2-P	63	270x270x25	110x51	125
AGP3-P	63	270x270x30	110x51	125
AGP4-P	90	270x270x40	110x51	150
AGP5-P	90	330x330x40	128x51	150
AGP6-P	90	330x330x50	128x51	150
AGP7-P	90	330x330x50	128x51	150
AGP8-P	110	380x380x60	150x65	175
AGP9-P	110	380x380x60	150x65	175
AGP1-VI	-	200x200x25	50x50	105
AGP2-VI	-	260x260x30	110x51	131
AGP3-VI	-	260x260x30	110x51	131
AGP4-VI	-	260x260x40	110x51	131
AGP5-VI	-	330x330x40	128x51	151
AGP6-VI	-	330x330x50	128x51	151
AGP7-VI	-	330x330x50	128x51	151
AGP8-VI	-	370x370x50	150x65	156
AGP9-VI	-	370x370x60	150x65	156

Note: an anchor can contain more than 9 strands. The full range of ground anchors is listed in STO STS 003-2018.





GROUND ANCHOR COMPONENTS

HIGH STRENGTH STRANDS

High-strength strands are the main structural component, running along the entire anchor length and serving as an anchor tendon that transfers force from the anchor head onto the bond length and then to the soil.



Geometric and strength parameters of strands are specified in **GOST R 53772-2010**, **GOST 13840** and **EN10138**.



CAST-IN DEAD-END ANCHOR

A cast-in dead-end anchor is installed at the ends of the ground anchor length. A "dead-end anchor" is a frame-type structure consisting of 7 strands. The dead-end anchor fixation in the grout is ensured by its three-dimensional design, as well as strand adhesion to the grout.



Dead-end anchor diameter for temporary anchors - **95 mm**, for permanent ones - **48 mm**.

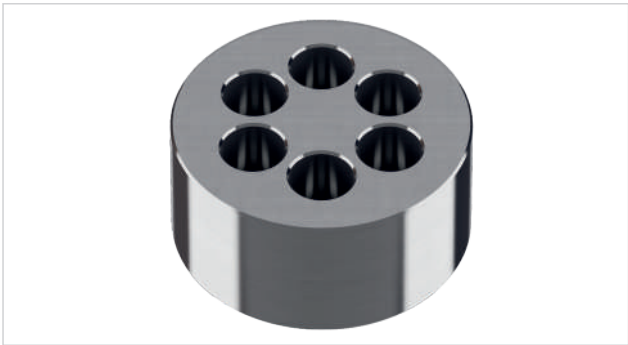
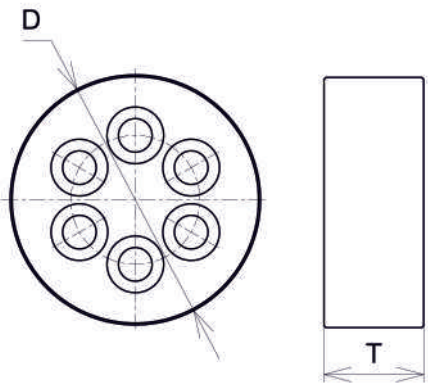
ANCHOR HEADS

An anchor head is a steel component that holds one or more strands with wedges and transfers the load onto the base plate



Anchor heads are made of steel in accordance with **GOST 1050**

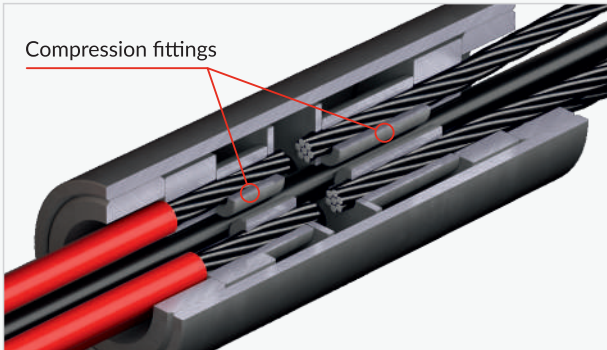
No. of strands, pcs.	T, mm	D, mm
1	50	50
2	51	110
3	51	110
4	51	110
5	51	128
6	51	128
7	51	128
8	65	150
9	65	150




COMPRESSION FITTINGS
AND EXTRACTION UNIT

Compression fittings (CFs) serve as a stationary uniform-strength anchor on a strand. CFs are used in extraction units for AGP-VI.

Our company can provide any extraction force as per design requirements.

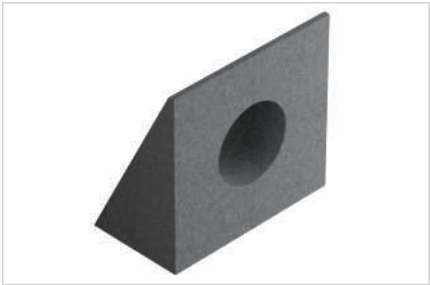


 The length of compression fittings depends on the pull-out force. The greater the force, the longer the fitting, and, therefore, the extraction unit itself.

BEARING PLATES

A bearing plate is a steel plate with overall dimensions calculated based on bearing conditions on concrete enclosures with a strength class of B25 or higher.
A bearing plate transfers the load onto the structure.

Our company also manufactures bearing plates from ultra-high-strength steel fiber concrete with customized dimensions and for various angles of inclination of ground anchor.



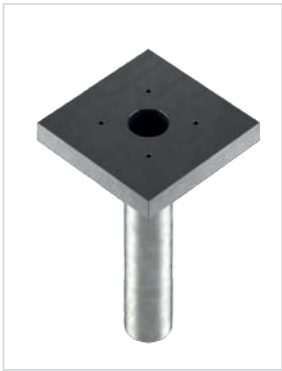
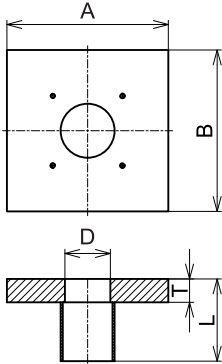
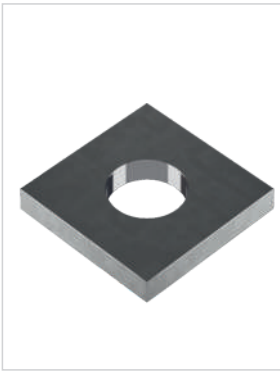
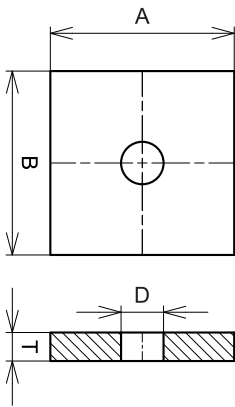
Bearing plate

AGP-V/AGP-VI

No. of strands, pcs.	A, mm	B, mm	D, mm	T, mm
1	200	200	17,2	25
2	260	260	68	30
3	260	260	68	30
4	260	260	68	40
5	330	330	88	40
6	330	330	88	50
7	330	330	88	50
8	370	370	107	50
9	370	370	107	60

AGP-P

No. of strands, pcs.	A, mm	B, mm	T, mm	D, mm	L, mm
1	200	200	25	17,2	405
2	270	270	25	68	405
3	270	270	30	68	410
4	270	270	40	68	420
5	330	330	40	88	520
6	330	330	50	88	530
7	330	330	50	88	530
8	380	380	60	107	540
9	380	380	60	107	540



GROUND ANCHOR COMPONENTS

CENTRALIZERS

Centralizers are used to center a tendon (with diameter d) inside a drill hole (with diameter D) and ensure the required cement layer thickness across the drill hole volume.

Centralizer design depends on a number of strands to be used in the anchor. Centralizers are spaced at 2 m intervals along the entire anchor length.



CORRUGATED DUCT

Corrugated ducts are used for anti-corrosion protection of strands in permanent anchors. Corrugated duct diameter depends on the number of strands in the ground anchor.

No. of strands, pcs.								
1	2	3	4	5	6	7	8	9
corrugated duct \varnothing , mm								
63	63	63	90	90	90	90	110	110

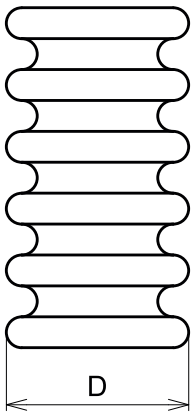


SPACERS

A spacer is a device that forms dead-end anchor to ensure uniform-strength anchoring of strands in the cement rock of the bond length part.



Spacers are installed along the entire bond length at 1 m intervals, their number depends on the bond length.

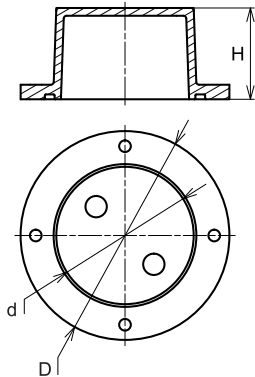


WEDGES

The three-pcs wedge that secures and fastens a stressed seven-wire strand. A wedge provides for strand self-wedging in the tapered hole of the anchor head. The number of wedges is equal to the number of ground anchor strands.

PROTECTION CAPS

Protection caps are installed on permanent anchor heads, and then a special grease is pumped inside to prevent corrosion of strands, wedges and heads.



No. of strands, pcs.	D, mm	d, mm	H, mm
1	180	109,5	94
2			
3	215	141,5	94
4			
5			
6	235	163,5	94
7			
8	265	184,5	110
9			

SHEATHING

A sheathing is used as a protection for strands covered with anti-corrosion grease along the free length of the ground anchor.



HEAT-SHRINK SLEEVES AND CAPS


Number of strands in AGP-V/ AGP-VI/ AGP-P, pcs.								
1	2	3	4	5	6	7	8	9
Cap ø before shrinkage/ø after shrinkage, mm								
55/25							75/30	
Heat-shrink sleeve 30x15 L=103 mm								



A heat-shrink cap is an end piece for strand fixation at the anchor end.

GROUTING TUBES

Grouting tubes are used to feed the grout into the drill hole. During the primary grouting the drill hole is evenly filled with cement grout, and during the secondary grouting pear-shaped flares are formed in the bond length in order to increase the anchor bearing capacity.

 One tube is used for primary grouting. For secondary grouting, 2-3 tubes are used. The number of tubes can vary depending on the design requirements.



EQUIPMENT

DGA HYDRAULIC JACKS

DGA hydraulic jacks are used for stressing ground anchor strands.

Specifications	DGA-80	DGA-140	DGA-200	DGA-250
Number of strands, max.	3	6	9	11
Max jacking force, kN (tf)	800 (81,5)	1400 (142,7)	2000 (203,9)	2500 (254,8)
Operating pressure, MPa	70	70	70	70
Piston area, cm ²	114,3	200	285,7	357,1
Rod stroke, mm	250	250	250	250
Weight, kg	88	120	142	262
Jack dimensions, mm	H=250 L=265 D=210 L1=250	H=250 L=320 D=240 L1=250	H=250 L=385 D=310 L1=250	H=250 L=533 D=360 L1=250

A spacer is required for wedging into the anchor head

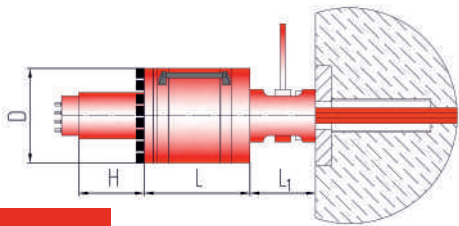


SPACER

PUMP STATIONS

A pump station provides hydraulic power for the high-pressure DGA jack used to stress ground anchor strands.

Specifications of SN 70/1/10/2.R	
Nominal pressure, MPa	70
Oil tank capacity, l	14
Effective volume, l	10
Dimensions, mm	375x435x560
Weight, kg	50



Jack geometry



DGA-250



DGA-140



DGA-80



USI P-70-85 GROUTING MACHINE

A grouting machine is used to prepare water-cement grout and feed it into the drill hole.



USI P-70-85	
Mixing tanks, l	2 tanks, 250 l each
Storage tank, l	70
Dosing water tank, l	100
Electric motor: Voltage, V Power, kW	380 22
Piston pump: Delivery rate, l/min Operating pressure, MPa	55 7
Weight, kg	1150
Dimensions, mm	2800x1450x2400

GPF-Z

GPF-Z series hydraulic press is used to make a dead-end anchor at the end of the bond length of single-strand ground anchors. A dead-end anchor ensures equal uniform-strength anchoring in cement rock.



Specifications	Value
Operating force, kN	58
Operating stroke, mm	100
Dimensions, mm	695x250x170
Weight (without operating fluid), kg	45
Operating pressure, MPa	15

UZM PRESS

UZM hydraulic press is used for making passive anchors consisting of a spring and a compression fitting.



Specifications	Value
Operating pressure, MPa	70
Operating force, kN	351,5
Piston stroke, mm	105
Dimensions, mm	230x230x513
Weight, kg	67

ENGINEERING MONITORING

FORCE MONITORING



One of the features of strand ground anchors is the ability to measure residual forces. Adapted heads and base plates are used for this purpose.

A jack is connected to an automatically controlled pump station. The pumping station automatically monitors the force of anchor head separation from the base plate, the anchor head movement relative to the plate and the jack piston movement. Anchor head compression force against the base plate is determined based on these data; this value represents the force in the anchor.

Anchor force measurement takes about 20 minutes and can be carried out an unlimited number of times.

FORCE SENSOR

A force sensor determines the actual value of the jacking force loss in the tendon during the force is transfer from the hydraulic jack onto the anchor head.

Specifications	Value
Force measurement range, kN	20-2500
Error margin, %	1
Operating temperature range, °C	-40...+60°C



LABORATORY TESTS



Our construction technology laboratory conducts the following tests with strands and grout:

- Strand tensile test;
- Stress relaxation tests;
- Test for stress corrosion in thiocyanate solution;
- Strand chemical analysis;
- Measurement of geometry;
- Bending tensile test;
- Compressive strength of mortar and grout;
- Physical characteristics of grout;
- Design of the grout mixture.



INSTALLATION PROCEDURE



I. Drilling

Depending on the soil stability, rotary drilling is carried out with a casing pipe or drilling mud.



II. Ground anchor installation

Then, an anchor tendon is installed so that the grouting tube outlet is protected from clogging and left outside the drill hole.



III. Primary grouting

Filling the drill hole with cement grout until it starts spilling out of the mouth.



IV. Secondary grouting

Secondary grouting is performed via grouting tubes, not earlier than 12 hours and not later than 24 hours after filling the drill hole with grout.



V. Strength gain

Cement rock gains strength in the period from 5 to 7 days.



VI. Anchor post-tensioning

Ground anchors are tensioned within 5 to 7 days after the last grouting, however not earlier than the cement rock reaches the strength of 21 MPa.

CARBON JACK



One of STS's developments is DKG carbon jack.

A distinguishing feature of this jack is using carbon fiber and aluminum as main materials in order to reduce weight.

No special machinery is required for transportation and installation of the jack, all operations can be done manually.

Specifications	DKG -140
Number of strands, max.	6
Max jacking force, kN (tf)	1373 (140)
Operating pressure, MPa	70
Piston area, cm²	200
Rod stroke, mm	230
Weight, kg	50
Jack dimensions:	
length, mm	420
height, mm	240
width, mm	240



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