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ANCHOR TECHNOLOGY

SW-RCD Anchor / SW-Smart Anchor / SW-Smart Jack /
SW-PCD Anchor / SW-PTF Anchor

Anchor Technology
SAMWOO

CEO MESSAGE

Greeting from the CEO

Having dedicated efforts to be the best in the ground anchor field over the last 20 years, Samwoo is endeavoring to enable safe and economical installations.

I would like to express the sincerest appreciation to our customers who have been supporting Samwoo.

Founded on October 22, 1993, Samwoo has been endeavoring to be the leader of ground anchor industry over the last 20 years. Through continuous R&D and advanced quality control, Samwoo is producing anchor products of outstanding quality that satisfy our customers in achieving safe and economical installations.

Samwoo is the first to obtain ISO 9001 certification in the field of ground anchor design, production and additional services in Korea. With R&D division, venture business registration and INNOBIZ certification, Samwoo is equipped with outstanding R&D competencies and technological power. Acknowledged of the superb management performance, business feasibility and possibility of development in the future with a number of certifications, Samwoo has advanced as the representative company of ground anchor in Korea.

As the leader of anchor market in Korea, Samwoo will not find satisfaction in our current achievement, but endeavor to be reborn as the representative anchor company of the world. Samwoo is currently supplying anchor technology through branch offices and joint stock companies all around the world, such as in Southeast Asia, Europe, Middle East and the U.S.

Our customers who are engaged in the ground-related design, installation, supervision and inspection fields!
Samwoo will satisfy all your needs for high-quality anchors. Samwoo will always try to provide support to our customers.
In the far-off future when anchors are needed to be built on the moon, we have absolutely no doubt that those anchors will be installed by Samwoo.

Thank you.

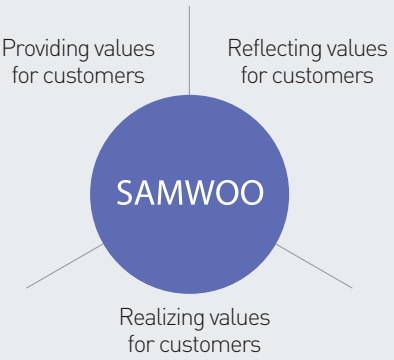
Kim, Jeong-Ryeol CEO of SAMWOO

SAMWOO

Anchor Technology SAMWOO

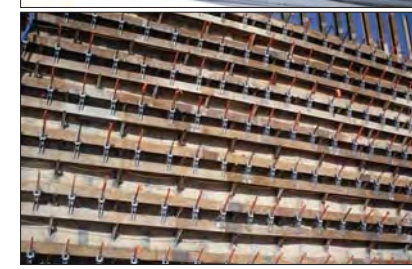
SAMWOO ANCHOR TECHNOLOGY

Established in 1993, Samwoo has been endeavoring to be the leader of the ground anchor industry. Through extensive and continuous R&D and advanced quality control, they have established themselves as the leading representative of ground anchor in Korea. In addition, Samwoo has opened branch offices and established partnerships in Southeast Asia, Europe and North America. Since Samwoo's initial development of the removable and permanent load-distributive anchors, their systems have been employed in numerous applications around the world providing lateral support to structural elements.



Company History

- Oct. 1993 Established Samwoo Engineering Ltd
- Apr. 1995 Built ground anchor manufacturing facility
- Jun. 1995 Established Samwoo Geotech Co., Ltd
- Sep. 1997 Extended ground anchor production line
- Sep. 1998 Obtained venture business certification
- Jun. 2000 Obtained ISO 9001 certification
- May. 2001 Established R&D division
- May. 2002 Exported ground anchor / Built new manufacturing facility in China
- Mar. 2005 Won commendation of the Commissioner of National Tax Service
- Jul. 2005 Built new manufacturing facility
- Aug. 2006 Opened contact office in Vietnam
- Dec. 2006 Obtained INNOBIZ certification
- Oct. 2007 Established Samwoo AnchorTec in the Netherlands, Europe
- Feb. 2008 Built ground anchor manufacturing facility in the Netherlands
- May. 2008 Installed movable ground anchor production line in Vietnam
- Mar. 2009 Established the branch office, Neo Samwoo Vietnam in Hanoi, Vietnam
- May. 2009 Established Research & Development center
- Jun. 2009 Samwoo designated as the promising small and medium business of export 2009
- Oct. 2009 Won the best thesis prize with thė SW-Smart anchor technique for weak ground'
- Nov. 2009 Established CATCO(Compressive Anchor Technology Company, LLC.) in Kansas, U.S
- Jul. 2010 Built ground anchor manufacturing facility in U.S (removable & permanent anchor production lines)
- Nov. 2010 Established Samwoo civil works in Hanoi, Vietnam
- Nov. 2010 Won the award for the commendation of Knowledge and Economy Minister
- Mar. 2011 Established Samwoo Construction Vietnam
- May. 2011 Designated as the Promising small and medium business of export firm 2011
- Nov. 2011 Obtained New technology from Korea rail network authority
- Mar. 2013 Made a business partnership for North and Central America with Skyline Steel, LLC



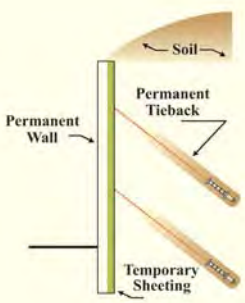
CONTENTS

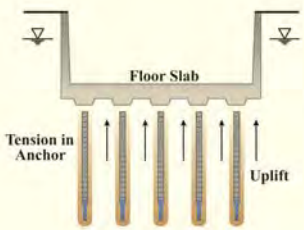
GROUND ANCHOR

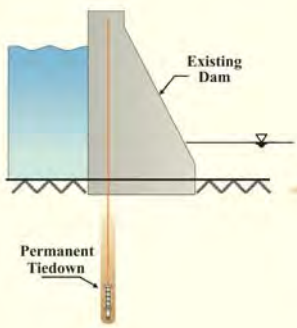
A ground anchor is a tension element used to apply a restraining force to a structure by anchoring the distal end of the anchor in the ground. Ground anchors have been used worldwide for over fifty years to restrain structures in intimate contact with the ground surface to provide stability to these structures and control deformations caused by active ground pressures.

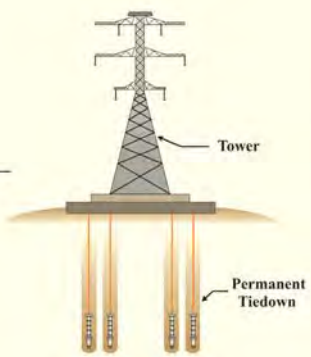
Applications for Ground Anchors

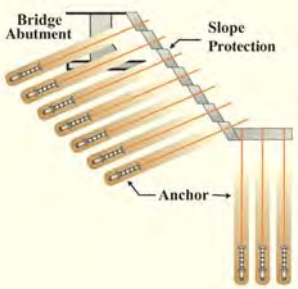
- Support of excavation for deep basement construction
- Highway retaining walls
- Grade separation retaining walls
- Rehabilitation of failing retaining walls
- Slope stability and landslide control
- Tiedown anchors to resist buoyancy forces
- Bridge abutment walls
- Tunnel portal walls
- Provide resistance to earthquake loading
- Resistance to overturning moments for towers and dams
- Anchorages for suspension bridges









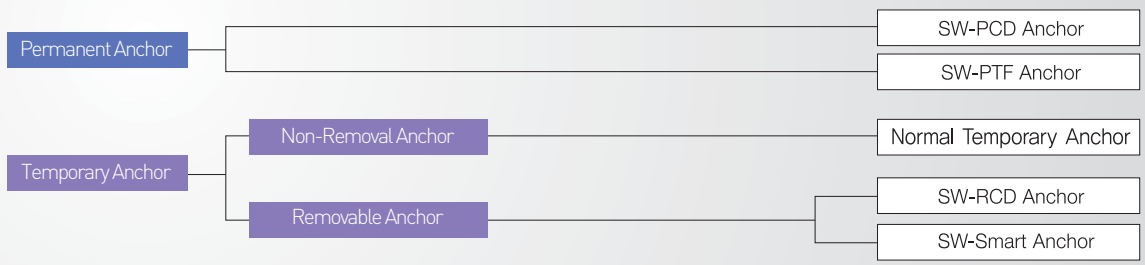


Ground Anchor Classification

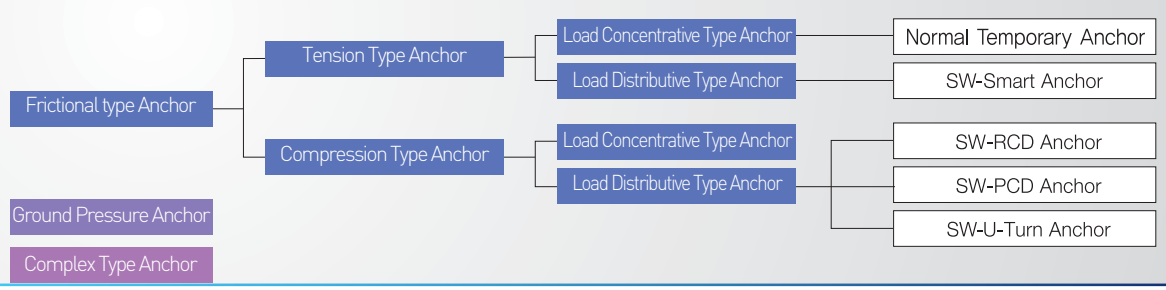
Ground anchors are classified according to their service life, purpose, installation procedures and method of load transfer from the anchor to the ground. The most common classification is as shown in the table below. Based on the service life, any prestressed anchor for temporary use, generally defined as having a service life less than 24 months is considered temporary anchor and having at least a 24 month service life is considered permanent anchor. Also, anchors can be classified into frictional type anchors that are supported by the friction of the grout and the ground, ground pressure type anchors that acquire anchoring force with the passive resistance of the ground using ground pressure boards, and complex type anchors that are a combination of the above two types. Frictional type anchors can also be classified into tension type anchors and compression type anchors based on the method of load transfer to the grout. In addition, tension type and compression type anchors can be classified into load concentrative type anchors and load distributive type anchors depending on the distribution of the load.

Samwoo Anchor Technology Product Groups

● Classification by Service Life



● Classification by Method of Load Transfer



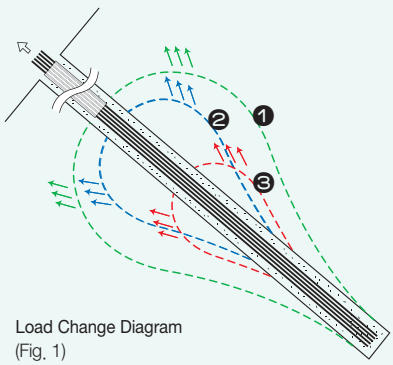
● Classification by Purpose of Use

Comparison of Features per Anchor Type

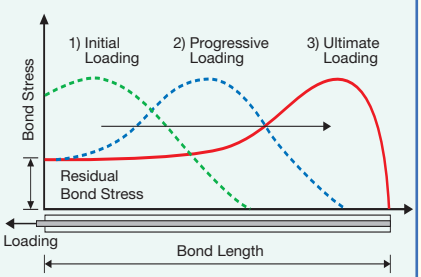
Load Concentrative Tension Type Anchor

When stress is applied to tension type anchor, load transfer occurs to bond length through adhesion of steel strand and grout. Due to load concentration, the parts of tension type anchor attached with steel strand and grout become unzipped and this leads to crack and load reduction.

In addition, tension type anchor has the weakness of progressive debonding and time-dependent load reduction (creep) occurrence when friction of load concentration zone exceeds the extreme skin friction of the target ground. As shown by (Fig. A), tension at the earlier phase displays the state as of ①. Then, as the parts attached with steel strand and grout become unzipped, it changes into the state as of ②. The relatively concentrated skin friction of anchor becomes higher than the allowed value between ground and grout body to progress into the state as of ③. Accordingly, load reduction takes place.



Load Change Diagram
(Fig. 1)

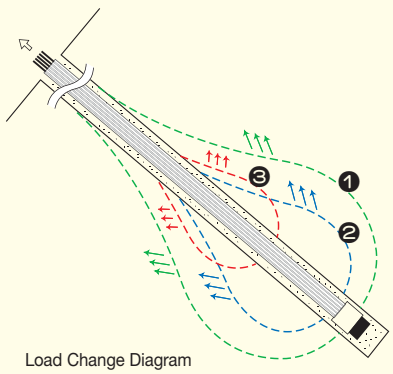


〈 Load Distribution Graph (Fig. A) 〉

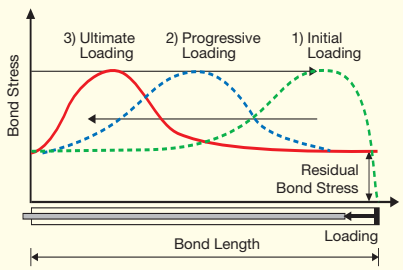
Load Concentrative Compression Type Anchor

Compression type anchors consist of an unbonded polyethylene (PE)-coated steel strand which transfers the jacking force / load directly to a structural element located at the distal end of the anchor. Unlike the tension type anchors, the grout body for compression type anchors is loaded in compression which is capable of securing much higher loads. However, due to the concentrative design of these anchors, the use of high-strength grout is frequently required to secure the jacking forces at the distal end. Also, it is often difficult to secure concentrative anchorage force in weak soils.

Similar to the tension type anchors, compression type anchors are subject to the occurrence of progressive debonding and time-dependent load reduction (creep) as displayed in state ① as shown in (Fig. B). In this case the friction required to secure the concentrated load exceeds that of the skin friction for that zone. This effect causes grout debonding and loss of soil confinement pressure resulting in load reduction as displayed in states ② and ③.



Load Change Diagram
(Fig. 2)



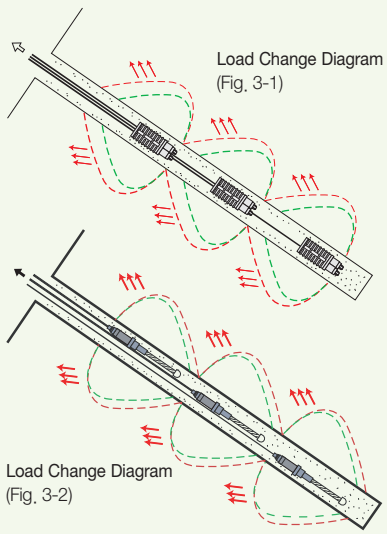
〈 Load Distribution Graph (Fig. B) 〉

Load Distributive Tension / Compression Type Anchor

As discussed, high stresses from tension and conventional compression type anchors transfer concentrated loads to the soil and grout body which can become overstressed resulting in failure. Therefore, load distributive compression type anchors have been developed and are being used, which uniformly distribute the anchor load to the grout body and soil along the theoretical length of the bond zone. In addition the grout strength requirements are reduced as well as applied eccentricity. As a result high loads can be achieved even in normal soil condition.

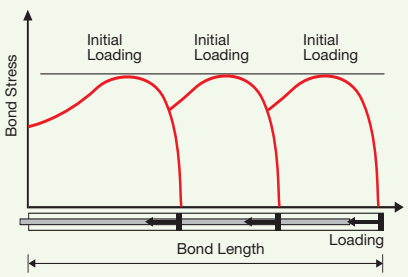
Recently, load distributive tension type anchors have been developed which are capable of securing stable loads in even relatively weak soils such as clay and silts. These anchors do not require high-strength grout and have low eccentricity as well.

The use of load distributive anchors results in a more uniform distribution of the anchor force to the soil as illustrated in figure C below. Therefore, load reduction and creep are minimized, enabling the anchor to maintain initial design load.



Load Change Diagram
(Fig. 3-1)

Load Change Diagram
(Fig. 3-2)



〈 Load Distribution Graph (Fig. C) 〉

ANCHOR TECHNOLOGY

SW-RCD ANCHOR

SamWoo-Removable, Compressive and Distributive Anchor

The SW-RCD anchor is a load distributive compression type removable anchor that offers a complete solution where anchorage systems required to be removed once they become redundant. Often city municipalities and the like, object to obstructions left in the ground beyond completion of construction for fear they will conflict with future developments or seek third party approval. The SW-RCD anchors are a cost effective solutions where the use of conventional tieback anchors are forbidden or discarded due to logistical and or practical site constraints. The entire steel strand can be quickly and easily removed or reengaged with limited site access. Simply rotate the strand to release the wedges which are fixed in the end of the anchor body and the entire steel strand is easily withdrawn through the PE sheath leaving the small aluminum anchor body. The removal process is generally done by hand. In addition, allowing the steel strand to penetrate through the inside and be secured to the end of the anchor body, distributes the jacking force along the length of the anchor body which maximizes the effective cross-sectional area of the grout body. Since their initial development these anchors have been employed in numerous projects around the world providing lateral support to temporary sheeting and shoring conditions.

Classification	● Removable Anchor (SW-RCD Anchor) 
Material	Corrosion-resistant aluminum anchor body
Manufacturing Method	Aluminum die-casting technique
Anchor Body Structure	• Steel strand built-in structure protects PE sheath and steel strand. • Precision combined method and structure created by die-casting technique prevent grout infiltration.
Performance	• Due to decrease in grout debonding, removal performance increases. • Due to high precision and steel strand built-in technique, removal performance increases.

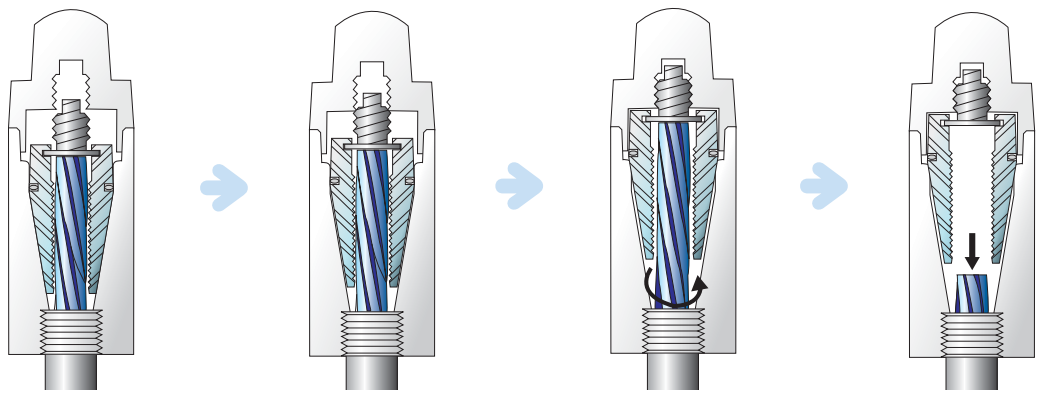
▶ SW-RCD ANCHOR

Features

① Jacking force is distributed and applied uniformly along the bond length which is ideal for relatively instable soils such as clay.
② No. of steel strands are freely adjustable according to the design loads and soil conditions.
③ Maximum design load of 1800kN can be achieved when utilizing a combination of (3) 4-strand anchor bodies (value based on 15.2mm dia. steel strands x 12 strands).
④ The HDPE sheath provides a high quality, uninterrupted plastic bond breaker and additional corrosion protection.
⑤ Steel strand can be easily removed or reengaged to the body by simple rotating the strand with a pair of pliers. Therefore, site access and removal process is minimized.
⑥ The strands are individually secured to the end of the anchor body which maximizes the design performance and reduces eccentricity.
⑦ Load distributive compression type anchors uniformly distribute the jacking force to the soil which minimize creep and potential for resulting load loss.
⑧ Anchors are manufactured in a semi-automated standardized facility with state of the art equipment resulting in stringent quality control and outstanding quality assurance.
⑨ Anchors are fully assembled and packaged in coils for transportation and job site convenience. The packaging is also ideal for long-term storage of anchors.

Principles of SW-RCD Anchor Removal

Upgraded
- ▶ The newly developed corrosion-protection aluminum die-casting anchor body
- ▶ More improved component with precision and combination method
- ▶ High-tech structure for strand protection and prevention of grout infiltration



① Stressing and lock-off
② Cutting strand, moving wedge
③ Rotating strand, releasing wedge
④ Removing strand

How to Remove ▶
① Cut steel strand, separate steel strand from waler, and then remove waler.
② Rotate steel strand clockwise and release wedge.
③ Manually remove steel strand separated from the wedge.

SW-RCD Anchor : Design/ Specifications

Table 1. SW-RCD Anchor Specification (15.24mm) (ASTM A-416 270 Grade, Low Relaxation) [ASTM A-416]

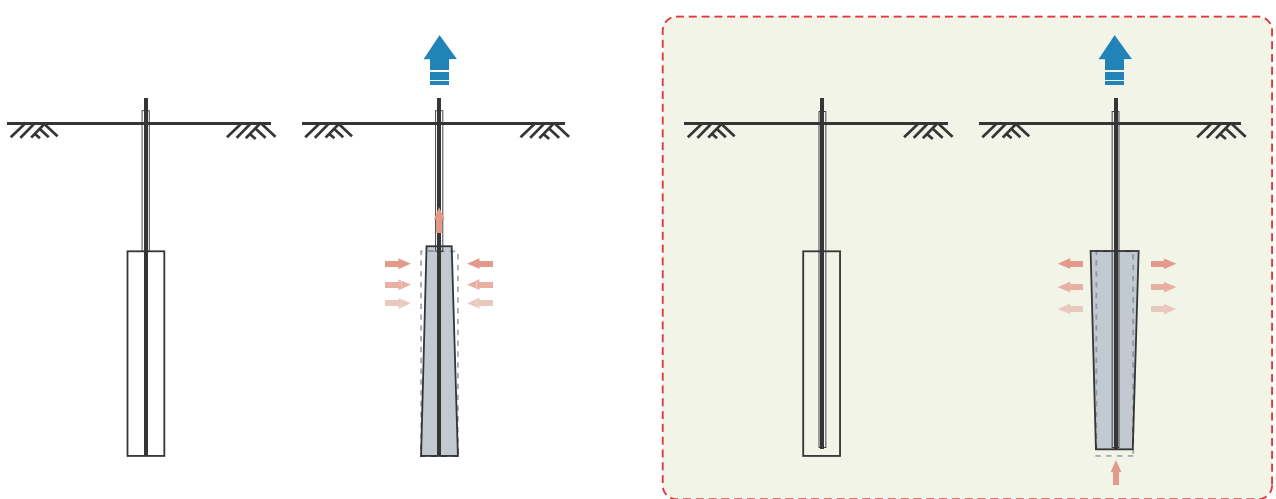
No. of Steel strand (ϕ=15.24mm)	Ultimate Strength (kN)	Yield Strength (kN)	Allowable Design Load (Ta) (kN)	Remarks
3	782	704	469	* Ultimate Strength (Tu) = 260.7 kN(1 strand) * Yield Strength (Ty) = 234.6 kN(1 strand) * Allowable Design Load (Ta) = 0.6 Tu * Maximum Lock-off Load = 0.7 Tu * Maximum Stressing Load = 0.8 Tu Reference FHWA-IF-99-015
4	1,043	938	626	
5	1,304	1,173	782	
6	1,564	1,408	939	
7	1,825	1,642	1,095	
8	2,086	1,877	1,251	
9	2,346	2,111	1,408	
10	2,607	2,346	1,564	
11	2,868	2,581	1,721	
12	3,128	2,815	1,877	

Table 2. SW-RCD Anchor Specification (15.70mm) (BS-5896 Super Grade, Low Relaxation) [BS-5896]

No. of Steel strand (ϕ=15.70mm)	Ultimate Strength (kN)	Yield Strength (kN)	Allowable Design Load (Ta) (kN)	Remarks
3	837	720	523	* Ultimate Strength (Breaking load) (Tu) = 279 kN(1 strand) * Yield Strength (Load at 1% Elongation (Ty) = 240 kN(1 strand) * Allowable Design Load (Ta) = 0.625 Tu * Maximum Lock-off Load = 1.1 Ta * Maximum Stressing Load = 0.8 Tu Reference BS-8081
4	1,116	960	698	
5	1,395	1,200	872	
6	1,674	1,440	1,046	
7	1,953	1,680	1,221	
8	2,232	1,920	1,395	
9	2,511	2,160	1,569	
10	2,790	2,400	1,744	
11	3,069	2,640	1,918	
12	3,348	2,880	2,093	

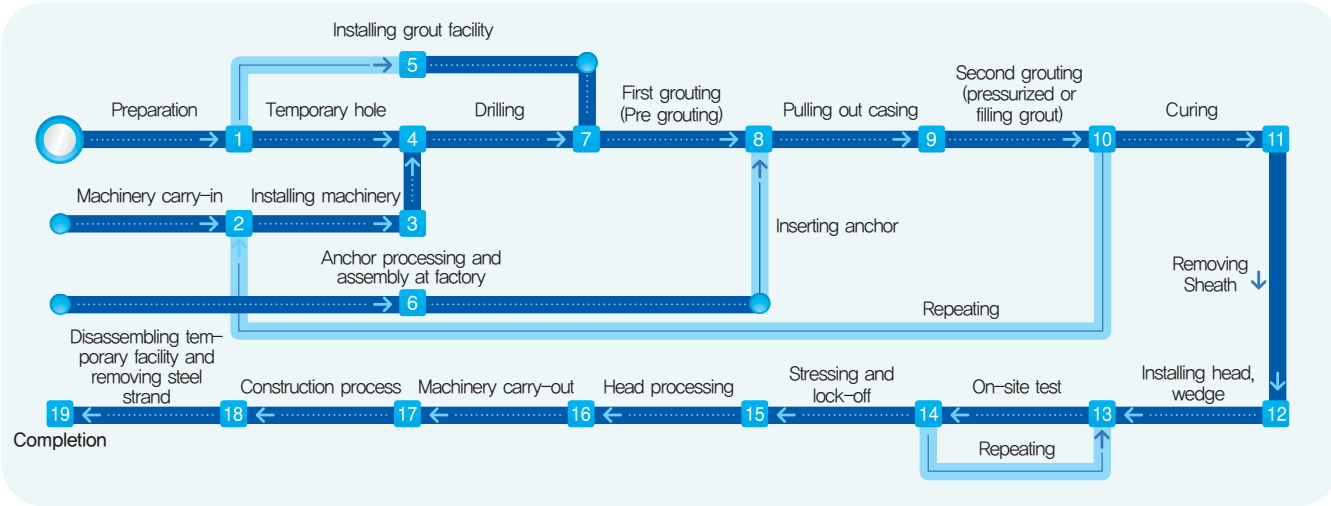
Strengths of Compression Type Anchor

As the anchors are loaded as illustrated below, the grout body is subject to compressive or tensile stresses. In the case of compression type anchors with applied compressive stress, the diameter of the grout body expands as a function of Poisson's ratio. As a result, frictional resis-tance between the grout body and soil increases. Also, the additional confining soil pressure due to the expansion of the grout body will increase the ultimate compressive strength of the grout. This is known as the confining pressure effect and is an advantage of compression type anchors. (Memoir of the Korean Society of Ocean Engineers, Vol. 17, 2003)

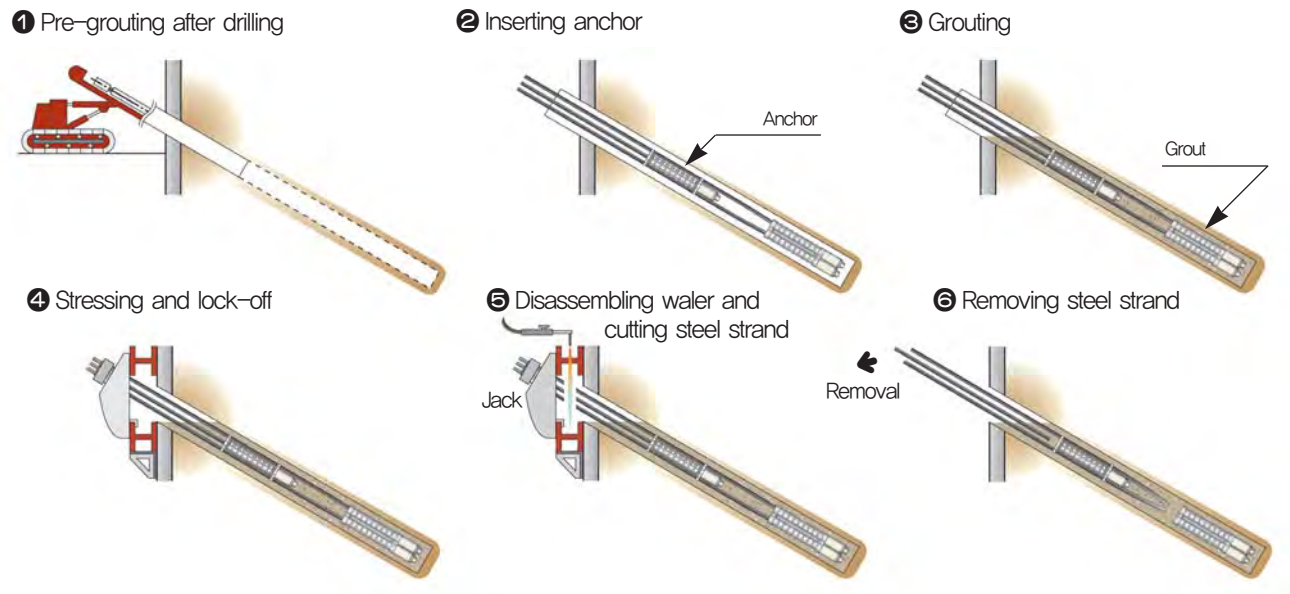


Tension Type Anchor (Before Stressing) | Tension Type Anchor (After Stressing) | Compression Type Anchor (Before Stressing) | Compression Type Anchor (After Stressing)

SW-RCD Anchor : Installation Process



SW-RCD Anchor Installation Flow



SW-RCD Anchor Guidelines

1. Care shall be taken so not to damage PE sheath surrounding steel strand. Grout inside sheath can bond to steel wire resulting in removal difficulties.
2. Care shall be taken not to twist the anchor during insertion into the borehole. Excessive twisting may result in pressure exerted on PE sheath from grout during curing process. The grout pressure may pinch the sheath against the steel strand making removal of strand difficult.
3. While applying jacking force, accurately check load and immediately stop operation if excessive displacement / strand elongation in noted. Excessive jacking force can result in grout failure adjacent to anchor body. The fractured grout can put undo stress on the PE sheath affecting the strand removal characteristics of the anchor.
4. When conducting oxygen cutting procedure for removal of steel strand, make sure a minimum of 20cm remains for removal operation. Cutting strand too short can make rotation of strand difficult.
5. When storing or moving anchors at construction site, it is important that the anchor bodies are not soiled with dirt or foreign debris. Anchor contamination will result in a decrease in bond and grout compressive strengths, and overall anchor performance.
6. Caution is required to prevent collapsing of borehole when inserting anchor. Grout voids in borehole will result in reduced anchor capacity.

SW-RCD Anchor : Major Achievements

SW-RCD Anchor, an anchor removed by man force, has obtained a number of domestic and international patents. First commercialized in 2001, this system has produced enormous construction results over the area of approx. 8,500,000m for the past 13 years. This is currently the most widely used removable anchor in Korea.

Contractor	Project Name	Total Length(m)
Bauer Malaysia	LOT G (Malaysia)	11,389
Bauer Malaysia	LOT 348 (Malaysia)	7,593
Bauer Malaysia	Mudajaya Tower (Malaysia)	1,259
Singapore VSL	Singapore Metro Project (Singapore)	12,500
Bauer Malaysia	Damansara Uptown (Malaysia)	32,405
Bauer Malaysia	Pacific Star (Malaysia)	15,650
Hong Kong VSL	Tai Po Road (Hong Kong)	2,250
VINACONEX R&D	Vietin Bank (Vietnam)	18,203
POSCO E&C	Konkuk Univ. Star City, Gwangjin-gu, Seoul	26,538
Daewoo E&C	Seoul Subway Line No. 9: 901 Section	89,372
POSCO E&C	Juneve Shopping Mall, Dongbaek District, Yongin-si, Gyeonggi-do	34,977
Lotte E&C	City Park, in Yongsan, Seoul	42,991
Daewoo E&C	Daewoo Apt., Sindorim, Seoul	39,805
Daeduk E&C	Commercial & residential complex, Samsan-dong, Incheon	33,188
Sungwon	Sungwon Leciel, Sangbong-dong, Seoul	35,290
Daelim Industrial, GS E&C	Block A & C of Dongnam Logistics Mall, Jangji District, Seoul	85,683
KCC E&C	2-5A Section, Incheon International Airport Railway, Banghwa, Seoul	38,559
Shinyoung	G-Well City, Cheongju, Chungcheongbuk-do	48,507
SK E&C	Baebang District (SK E&C), Asan, Chungcheongnam-do	56,215
Lotte E&C	Gimpo Airport Lotte Sky Park, Seoul	41,801
Hanwha E&C	Research facility SD-2 in Techno Valley, Pangyo, Gyeonggi-do	40,459
KCC E&C	Inno Valley KCC, Pangyo, Gyeonggi-do	48,182
Lotte E&C	Lotte World 2, Jamsil, Seoul	91,945
Dongbu E&C	Centreville, Yongsan, Seoul	46,771
AMCO	Premier's amco, Sangbong-dong, Seoul	115,000
GS E&C	NC SOFT R&D center, Pangyo-dong, Bundang-gu, Gyeonggi-do	35,931
POSCO E&C	N-Square multiplex building, Pangyo-dong, Bundang-gu, Gyeonggi-do	56,593

SW-SMART ANCHOR

The SW-SMART anchor is a load distributive tension type removable anchor designed to uniformly transfer skin friction to the grout body and soil throughout the entire bond length rather than applying a concentrated force at the distal end of the anchor body. This anchor has been developed for the purpose of securing anchorage force in relatively weak soils of approx. N ≤ 10. Removal of the SW-SMART anchor is performed similar to that of the SW-RCD anchor.

Features

① The load distributive design allows the anchoring force to be secured in soils with low confining pressure (approx. N ≤ 10).
② Minimize working space required for removal of steel strand.
③ Strand is easily removed which minimizes removal cost.
④ Materials for bond and free length can be freely selected. (Ex.: Free length - steel strand, Bond length - steel bar)
⑤ Anchoring force can be secured even when compressive strength of grout body is lower than that of compression type anchor.
⑥ The target anchoring force can be easily secured in soils with low confining pressure due to the lower eccentric design.
⑦ When applied to weak ground, workability, convenience and economic efficiency are outstanding in comparison to other techniques.

SW-Smart Anchor : Design/ Specifications

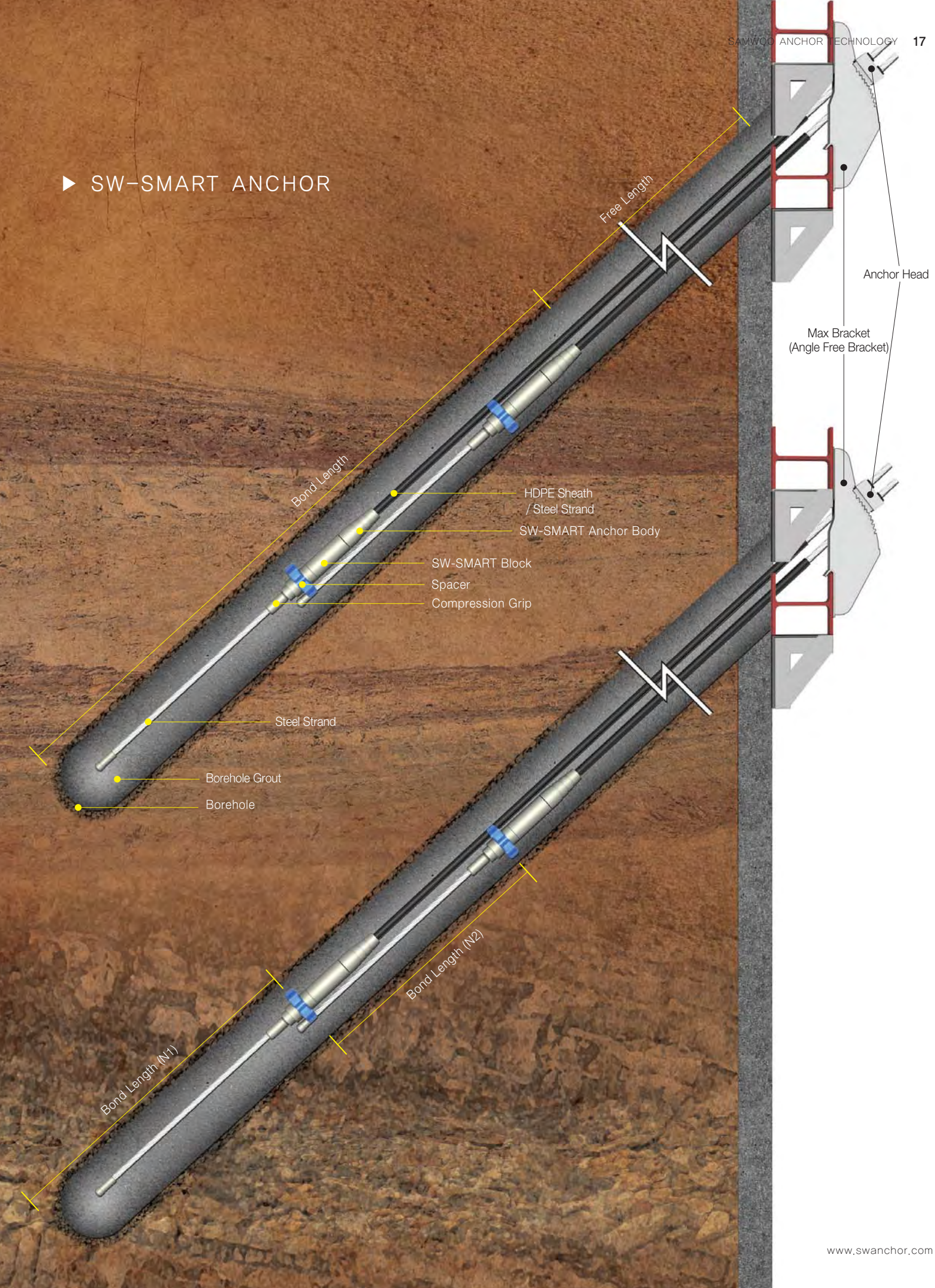
Table 1. SW-SMART Anchor Specification (15.24mm) (ASTM A-416 270 Grade, Low Relaxation) [ASTM A-416]

No. of Steel strand (ϕ=15.24mm)	Ultimate Strength (kN)	Yield Strength (kN)	Allowable Design Load (Ta) (kN)	Remarks
3	782	704	469	* Ultimate Strength (Tu) = 260.7 kN(1 strand) * Yield Strength (Ty) = 234.6 kN(1 strand) * Allowable Design Load (Ta) = 0.6 Tu * Maximum Lock-off Load = 0.7 Tu * Maximum Stressing Load = 0.8 Tu Reference FHWA-IF-99-015
4	1043	938	626	
5	1304	1,173	782	
6	1564	1,408	939	
7	1825	1,642	1,095	
8	2086	1,877	1,251	
9	2346	2,111	1,408	
10	2607	2,346	1,564	
11	2868	2,581	1,721	
12	3128	2,815	1,877	

Table 2. SW-SMART Anchor Specification (15.70mm) (BS-5896 Super Grade, Low Relaxation) [BS-5896]

No. of Steel strand (ϕ=15.70mm)	Ultimate Strength (kN)	Yield Strength (kN)	Allowable Design Load (Ta) (kN)	Remarks
3	837	720	523	* Ultimate Strength (Breaking load) (Tu) = 279 kN(1 strand) * Yield Strength (Load at 1% Elongation) (Ty) = 240 kN(1 strand) * Allowable Design Load (Ta) = 0.625 Tu * Maximum Lock-off Load = 1.1 Ta * Maximum Stressing Load = 0.8 Tu Reference BS-8081
4	1,116	960	698	
5	1,395	1,200	872	
6	1,674	1,440	1,046	
7	1,953	1,680	1,221	
8	2,232	1,920	1,395	
9	2,511	2,160	1,569	
10	2,790	2,400	1,744	
11	3,069	2,640	1,918	
12	3,348	2,880	2,093	

▶ SW-SMART ANCHOR



SW-SMART JACK

Manifold Jack

The smart Jack was developed to uniformly distribute the stressing force to individual strands of each anchor body. Load distributive type anchors uniformly distribute the stressing load to the grout body and soil along the theoretical length of the bond zone. The spacing of the anchor bodies in this manner results in various unbonded strand lengths and corresponding elongations. The conventional center-hole jack simultaneously stresses the steel strands which, if used for this application, will result in higher forces applied to upper anchor bodies and less to lower bodies as positioned in the borehole. Applying jacking force to the anchor bodies in this manner is not efficient and may result in overstressing of steel strands and anchor failure. The Smart Jack was developed and designed with multiple cylinders so each strand is stressed independently allowing the operator to inspect and manage elongations and jacking force of individual strands. This ensures that the jacking force is evenly distributed to individual strands based on their unbonded length and that no one strand is excessively loaded.

Features

① Stressing wedges are located at front end of unit which results in reduced anchor tail length requirements.

② Position of stressing wedges in unit minimizes bending of anchor tails during installation of jack prior to applying alignment load.

③ Lock-off system uniformly minimizes wedge slip.

④ Allows individual stressing of anchor bodies as required.

⑤ Jack weight is relatively light as compared to conventional jack. Therefore, it is easier to install and transport unit.

⑥ Jack was independently developed by Samwoo and has been suggestively used at numerous anchor installation projects in Korea and abroad.

SMJ - F 7P S200

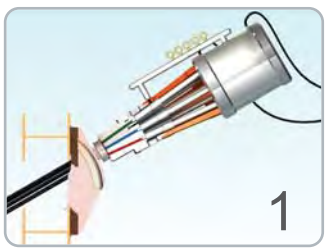
SMJA - 5P S250

SMJ - F 10P S300

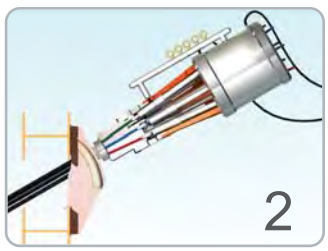
Model	SMJA - 4P S150	SMJA - 7P S200	SMJ - F 7P S200	SMJA - 5P S250	SMJ - F 10P S300
Cross-Section	21.54㎠ * 4ea	21.54㎠ * 7ea	28.24㎠ * 7ea	19.35㎠ * 5ea	28.24㎠ * 10ea
Maximum Load Per Rod	15.08 ton	15.08 ton	19.77 ton	13.55 ton	19.77 ton
Maximum Load	60.32 ton	105.56 ton	138.39 ton	67.75 ton	197.7 ton
Maximum Stroke	150 mm	200 mm	200 mm	250 mm	300 mm

*According to the customer's request, various specification is available for Smart Jack.

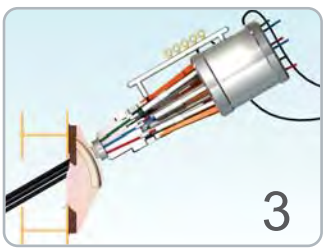
SW-Smart Jack Operation Mechanism



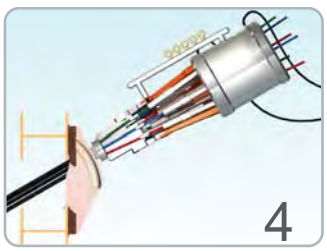
1. Setting SW-Smart Jack and preparing for stressing



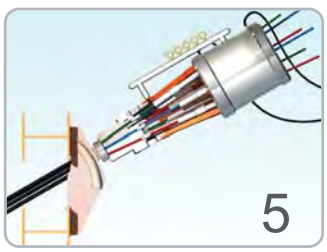
2. Stressing with SW-Smart Jack



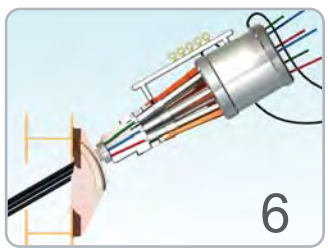
3. Stressing individual cylinders with the same load



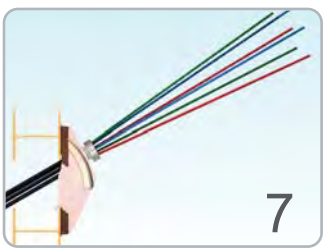
4. Elongation occurring due to difference in the length of steel strand



5. Difference in elongation upon completion of stressing



6. Initializing cylinder and lock-off anchor head after completion of stressing



7. Completing stressing with uniformed load considering length of steel strand

SW-Smart Jack : Example of Use

SW-PCD ANCHOR

SamWoo-Permanent, Compressive and Distributive

The SW-PCD anchor is a load distributive compression type permanent anchor which utilizes extruded steel strand for outstanding rust and corrosion resistance. The SW-PCD anchor is manufactured so that the extruded steel strand penetrates through the inside and secures to the end of the anchor body. This design distributes the jacking force along the length of the anchor body which maximizes the effective cross-sectional area of the grout body. Therefore, the compressive force transferred to the grout body is much higher than conventional compression type anchors. The SW-PCD anchors are used largely for permanent sheathing and shoring, tiedown anchors to resist buoyancy forces, slope stability and landslide control as well as numerous other applications.

Features

① Jacking force is distributed and applied uniformly along the bond length which is ideal for relatively unstable soils such as clay.

② The aluminum anchor body and corrosion resistance housing protects the SW-PCD anchor and provides a highly corrosion resistant system.

③ Corrosion resistant extruded steel strands penetrate through and are individually secured to the end of anchor body with greased grippers / end blocks placed inside galvanized / stainless steel sleeves and end caps with rubber rings. This assembly also offers outstanding corrosion protection.

④ No. of steel strands are freely adjustable according to the design loads and soil conditions.

⑤ Maximum design load of 1,800 kN can be achieved when utilizing a combination of (3) 4-strand anchor bodies (value based on 15.2mm dia. steel strands x 12 strands).

⑥ Load distributive compression type anchors uniformly distribute the jacking force to the soil which minimizes creep and potential for resulting load loss.

⑦ Anchors are manufactured in a semi-automated standardized facility with state of the art equipment resulting in stringent quality control and outstanding quality assurance.

⑧ Anchors are fully assembled and packaged in coils for transportation and job site convenience. The packaging is also ideal for long-term storage of anchors.

▶ SW-PCD ANCHOR

SW-PCD Anchor : Design/ Specifications

Upgraded
- The newly developed corrosion-protection aluminum die-casting anchor body
- More improved component with precision and combination method
- High-tech structure for strand protection and prevention of grout infiltration

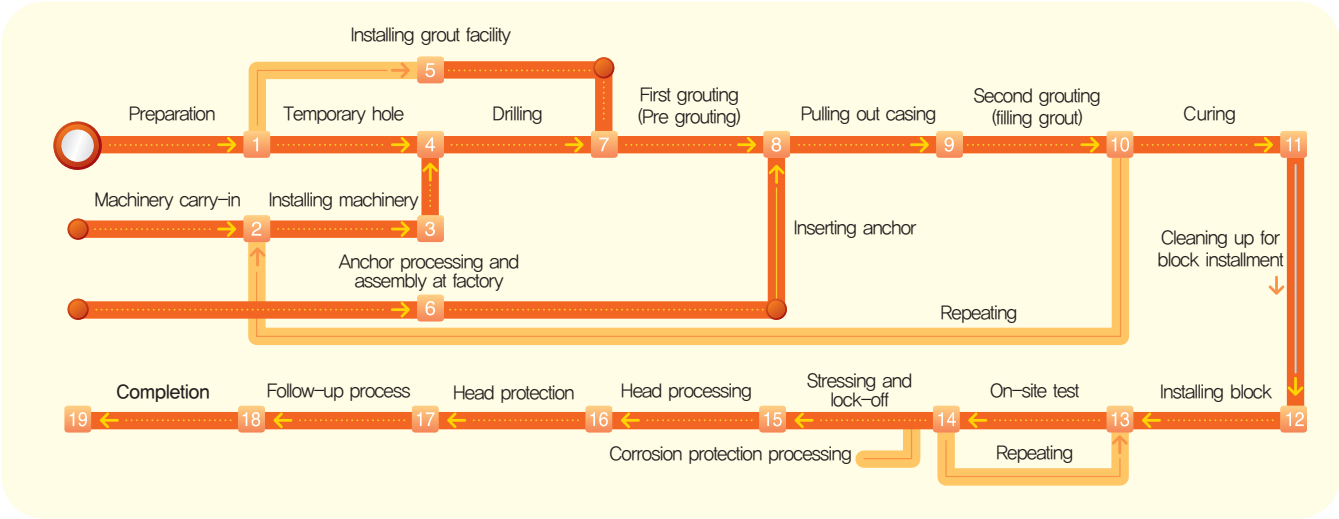
Table 1. SW-PCD Anchor Specification (15.24mm) (ASTM A-416 270 Grade, Low Relaxation) [ASTM A-416]

No. of Steel strand (ϕ=15.24mm)	Ultimate Strength (kN)	Yield Strength (kN)	Allowable Design Load (Ta) (kN)	Remarks
3	782	704	469	* Ultimate Strength (Tu) = 260.7 kN(1 strand) * Yield Strength (Ty) = 234.6 kN(1 strand) * Allowable Design Load (Ta) = 0.6 Tu * Maximum Lock-off Load = 0.7 Tu * Maximum Stressing Load = 0.8 Tu Reference FHWA-IF-99-015
4	1,043	938	626	
5	1,304	1,173	782	
6	1,564	1,408	939	
7	1,825	1,642	1,095	
8	2,086	1,877	1,251	
9	2,346	2,111	1,408	
10	2,607	2,346	1,564	
11	2,868	2,581	1,721	
12	3,128	2,815	1,877	

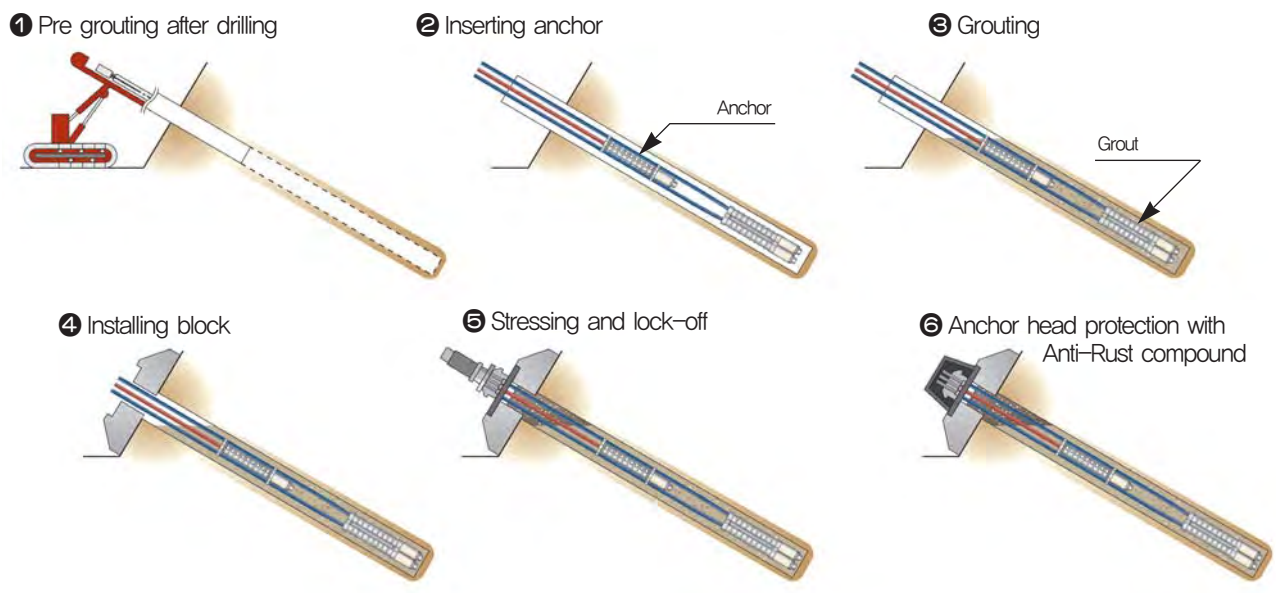
Table 2. SW-PCD Anchor Specification (15.70mm) (BS-5896 Super Grade, Low Relaxation) [BS-5896]

No. of Steel strand (ϕ=15.70mm)	Ultimate Strength (kN)	Yield Strength (kN)	Allowable Design Load (Ta) (kN)	Remarks
3	795	699	419	* Ultimate Strength (Breaking load) (Tu) = 279 kN(1 strand) * Yield Strength (Load at 1% Elongation (Ty) = 240 kN(1 strand) * Allowable Design Load (Ta) = 0.5 Tu * Maximum Lock-off Load = 1.1 Ta * Maximum Stressing Load = 0.8 Tu Reference BS-8081
4	1,060	932	558	
5	1,325	1,165	698	
6	1,590	1,398	837	
7	1,855	1,631	977	
8	2,120	1,864	1,116	
9	2,385	2,097	1,256	
10	2,650	2,330	1,395	
11	2,915	2,563	1,535	
12	3,180	2,796	1,674	

SW-PCD Anchor : Installation Process



SW-PCD Permanent Anchor Installation Flow



SW-PCD Anchor Guidelines

1. Care shall be taken so not to damage extruded steel strand coating. Damage to coating may result in wire corrosion resulting in permanent anchor classification issues.
2. When storing or moving anchors at constructions site, it is important that the anchor bodies are not soiled with dirt or foreign debris. Anchor contamination will result in a decrease in bond and grout compressive strengths and overall anchor performance.
3. Caution is required to prevent collapsing of borehole when inserting anchor. Grout voids in bore hole will result in reduced anchor capacity.

SW-PCD Anchor : Major Achievements

As a permanent anchor applied with outstanding corrosion and rust protection technologies, SW-PCD anchor was first commercialized in 2000. Since then, with superb workability and economic efficiency, this permanent anchor has been widely used for a variety of permanent purposes, such as resistance of buoyancy forces, stability of tunnel portal walls and bridge abutment walls, slope stability and landslide control for new installation and extension of roads.

Contractor	Project Name	Total Length(m)
Hyundai E&C	Yeonnam Elementary Schoo, Mabuk-ri, Yongin	6,835
Hyundai E&C	Military Mutual Aid Assoc. Apt., Mabuk-ri, Guseong, Yongin	14,314
Chungdo E&C	Gwangmyeong ~ Anyang road (Ori Rd.)	4,858
Daelim Industrial	Construction site, Nambumin-dong, Busan	10,041
Sambu	Central inland Yeoju ~ Gumi construction zone 11	75,816
Samsung C&T	Samsung Precision Chemical extension, Ulsan	5,334
Yongsan-gu Office	Road extension, Huam-dong, Yongsan	7,722
Kumho E&C	Daegu ~ Busan expressway construction zone 4	7,237
Samlim, Taean Construction	Busan ~ Jinhae STX Offshore & Shipbuilding D-04 construction zone	5,316
Kangsan Construction	Underground roadway, Dongbaek District, Yongin-si, Gyeonggi-do	6,366
Kyeryong Construction Industrial	Underground roadway, Dongbaek District, Yongin-si, Gyeonggi-do	11,465
Road Traffic Authority	Expressway construction zone 2, Donghae, Gangwon-do	6,280
Amco	Hyundai Mobis Western District Office, Paju, Gyeonggi-do	8,442
Hanil Construction	Hanil U&I Apt., Yangsan-si, Gyeongsangnam-do	35,873
Samhwan Corp.	Construction zone 3 between Gochang and Jangseong in Jeollabuk-do	10,696
Isu E&C	Brown Stone Gaya Apt., Gwangyang, Jeollanam-do	12,983
Hanshin E&C	Chuncheon & Yangyang Expressway construction zone 2, Gangwon-do	22,861
Daelim Industrial	Construction zone 1, National Asia Cultural Hall, Gwangju	28,110
Daelim Industrial	Construction zone 2, National Asia Cultural Hall, Gwangju	21,681
Posco E&C	Busan Millak-dong redevelopment site	4,280
Posco E&C	Busan Jaesong 1st zone House Development Projects	11,621
Posco E&C	Busan Millak-dong 1st zone	10,918
Samsung C&T	Geoje dormitory, Yeonje-gu, Busan,	9,418
Pacific E&C	Pocheon Daracdae laboratory site, Gyeonggi-do	8,559

LEADER OF GROUND ANCHOR

SW-PTF ANCHOR

SamWoo-Permanent, Tensile and Frictional

The SW-PTF, conventional tension type permanent, anchors have long been used for a variety of purposes throughout the world. The rust and corrosion resistance property of this anchoring system is ideal for permanent support of structures. The SW-PTF is used largely for permanent sheathing and shoring, tiedown anchors to resist buoyancy forces, slope stability and landslide control as well as numerous other applications.

Features

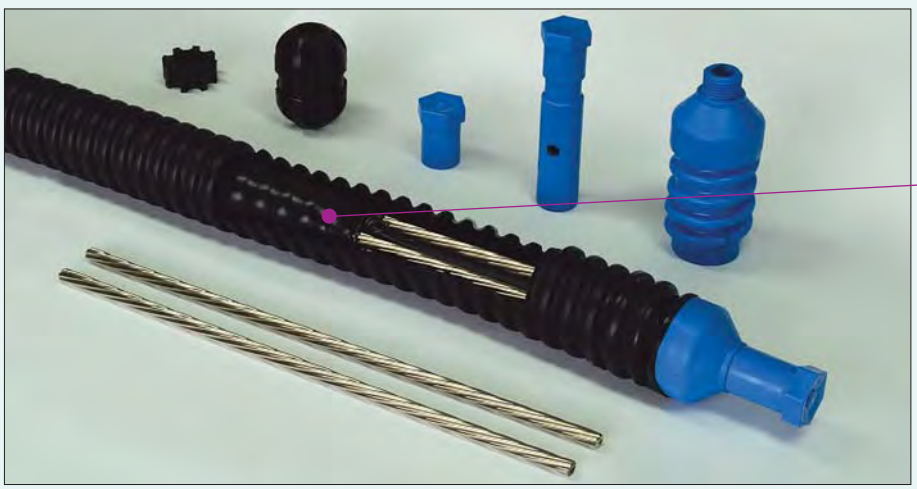
① Steel strand and corrugated sheath is freely adjustable according to design load and depth of installation.

② Anchors are manufactured in a semi-automated standardized facility with state of the art equipment resulting in stringent quality control and outstanding quality assurance.

③ Anchors are fully assembled and packaged in coils for transportation and job site convenience. The packaging is also ideal for long-term storage of anchors.

④ Optional plastic nose cone used at the distal end of the anchor provides clearance at the end of borehole adding additional protection and resistance to corrosion.

⑤ The both single protection and double protection can be supplied depending on client's request.



Heat Shrinkable Tube

◀ SW-PTF Anchor (Closed Type)

Heat Shrinkable Tube

◀ SW-PTF Anchor (Open Type)

▶ SW-PTF ANCHOR

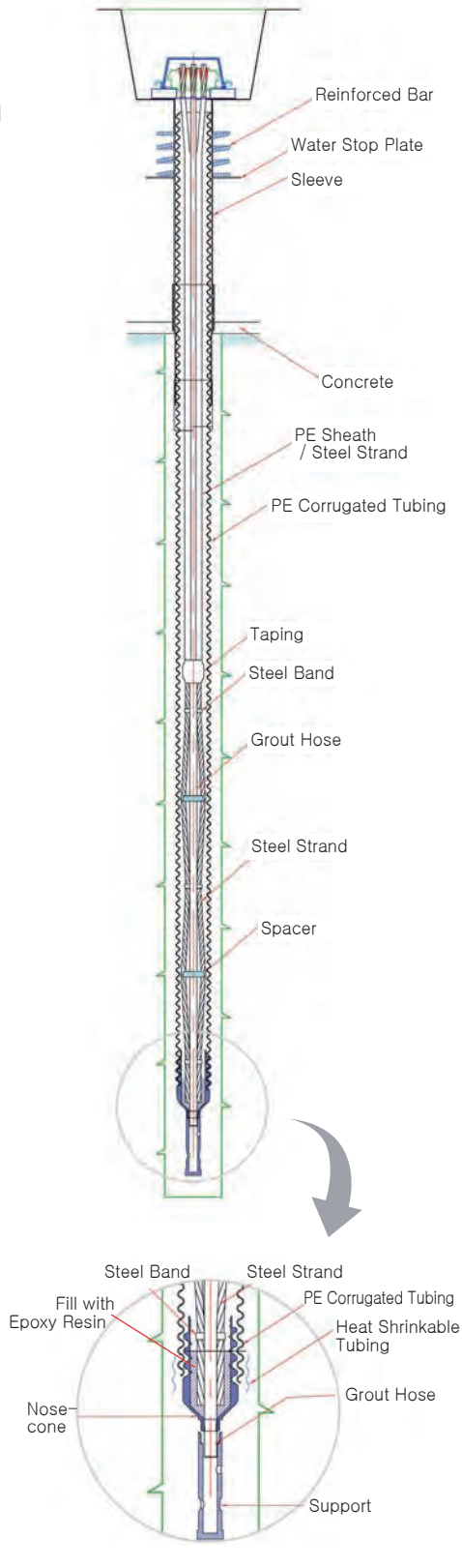
SW-PTF Anchor : Design/ Specifications

Table 1. SW-PTF Anchor Specification (15.24mm) (ASTM A-416 270 Grade, Low Relaxation) [ASTM A-416]

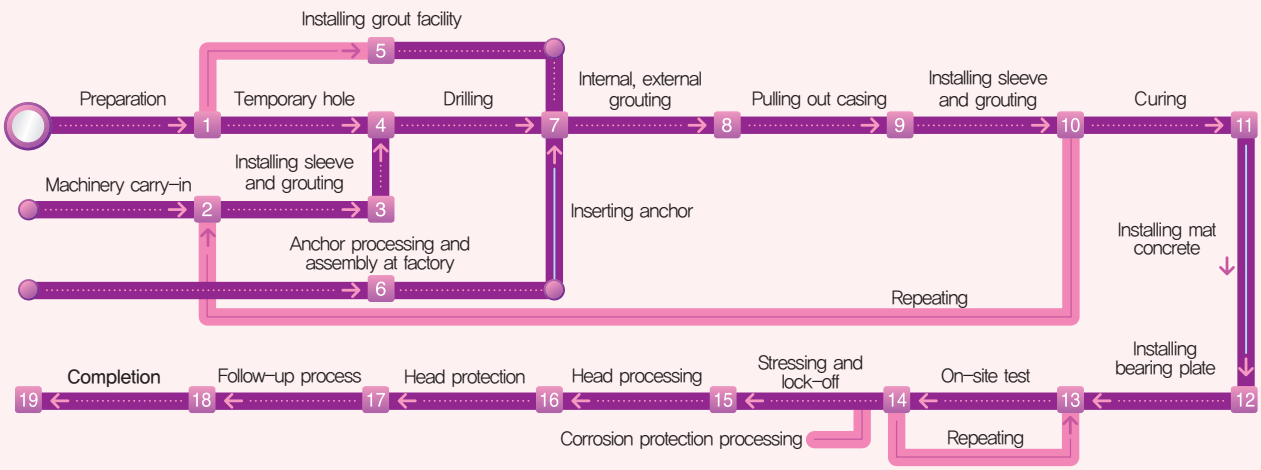
No. of Steel strand (ϕ=15.24mm)	Ultimate Strength (kN)	Yield Strength (kN)	Allowable Design Load (Ta) (kN)	Remarks
3	782	704	469	
4	1,043	938	626	
5	1,304	1,173	782	
6	1,564	1,408	939	
7	1,825	1,642	1,095	* Ultimate Strength (Tu) = 260.7 kN(1 strand)
8	2,086	1,877	1,251	* Yield Strength (Ty) = 234.6 kN(1 strand)
9	2,346	2,111	1,408	
10	2,607	2,346	1,564	
11	2,868	2,581	1,721	* Allowable Design Load (Ta) = 0.6 Tu
12	3,128	2,815	1,877	* Maximum Lock-off Load = 0.7 Tu
13	3,389	3,050	2,034	* Maximum Stressing Load = 0.8 Tu
14	3,650	3,284	2,190	
15	3,910	3,519	2,346	Reference FHWA-IF-99-015
16	4,171	3,754	2,503	
17	4,432	3,988	2,659	
18	4,692	4,223	2,816	
19	4,953	4,457	2,972	

Table 2. SW-PTF Anchor Specification (15.70mm) (BS-5896 Super Grade, Low Relaxation) [BS-5896]

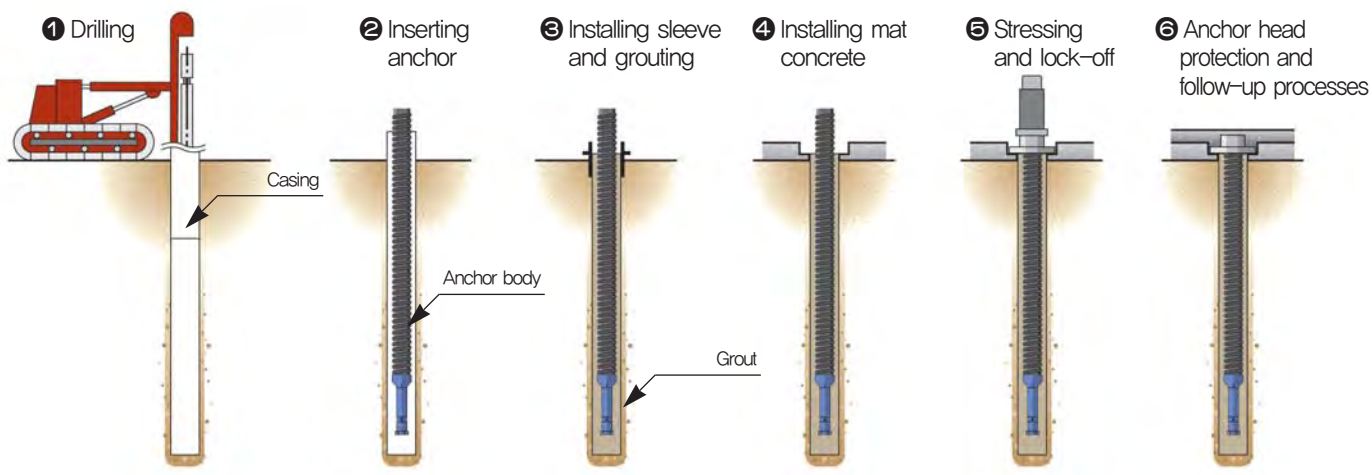
No. of Steel strand (ϕ=15.70mm)	Ultimate Strength (kN)	Yield Strength (kN)	Allowable Design Load (Ta) (kN)	Remarks
3	837	720	419	
4	1,116	960	558	
5	1,395	1,200	698	
6	1,674	1,440	837	
7	1,953	1,680	977	* Ultimate Strength (Breaking load) (Tu) = 279 kN(1 strand)
8	2,232	1,920	1,116	* Yield Strength (Load at 1% Elongation) (Ty) = 240 kN(1 strand)
9	2,511	2,160	1,256	
10	2,790	2,400	1,395	
11	3,069	2,640	1,535	* Allowable Design Load (Ta) = 0.5 Tu
12	3,348	2,880	1,674	* Maximum Lock-off Load = 1.1 Ta
13	3,627	3,120	1,814	* Maximum Stressing Load = 0.8 Tu
14	3,906	3,360	1,953	
15	4,185	3,600	2,093	Reference BS-8081
16	4,464	3,840	2,232	
17	4,743	4,080	2,372	
18	5,022	4,320	2,511	
19	5,301	4,560	2,651	



SW-PTF Anchor : Installation Process



SW-PTF Anchor Installation Flow

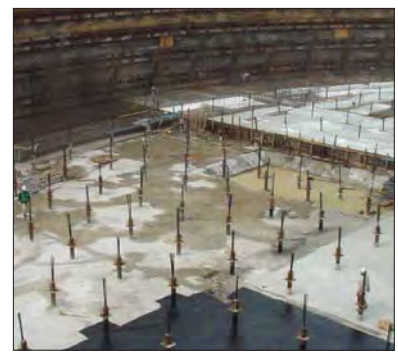


SW-PTF Anchor Guidelines

1. Avoid damaging corrugated sheath to prevent water infiltration and corrosion issues.
2. Care shall be taken when lowering anchor into borehole to prevent damaging nose-cone. Sudden impact to bottom of borehole can damage cone resulting in external grouting and anchor performance issues.
3. Care shall be taken to prevent damaging PE sheath covering steel strand. Damage to PE sheath may result in wire corrosion resulting in permanent anchor classification issues.
4. When storing or moving anchors at constructions site, it is important that the anchor bodies are not soiled with dirt or foreign debris. Anchor contamination will result in a decrease in bond and grout compressive strengths and overall anchor performance.
5. Caution is required to prevent collapsing of borehole when inserting anchor. Grout voids in bore hole will result in reduced anchor capacity.

SW-PTF Anchor : Major Achievements

SW-PTF Anchor with outstanding corrosion and rust protection structure has long been used for a variety of permanent purposes domestically and internationally, such as resistance of buoyancy forces, stability of tunnel portal walls and bridge abutment walls, slope stability, landslide control and etc.

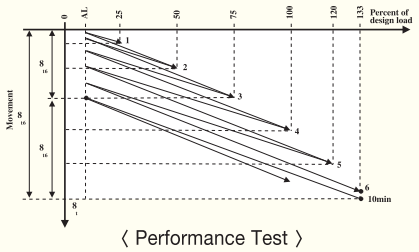


Contractor	Project Name	Total Length(m)
Hong Kong VSL	Hong Kong University (Hong Kong)	9,180
Geovert	KawaKawa project (New Zealand)	2,250
Kenber Geotechnic	East Railway project (Thailand)	6,300
KR VINA	Mong Duong1 Thermal Power Plant (Vietnam)	3,357
Jeremy James Pty Ltd	Darwin Marine Supply Base (Australia)	4,754
SONGDA JSC	HuaNa Hydro Power Plant (Vietnam)	10,970
Hanshin E&C	Sindorim Donga, Hanshin (Joheung Chemicals) Apt.	15,924
Samsung C&T	Redevelopment Apt., Sancheon District, Yongsan	29,656
Hyundai E&C	Busan International Exhibition Hall & Convention Center	15,954
Hankook Heavy Industries	Jugong Apt., Hwigyeong-dong	24,228
Hyundai Development Company	Anguk Apt., Incheon	13,575
Samsung E&C	Samsung Raemian model reconstruction project, Dangsan-dong	25,000
Hyundai E&C	Reconstruction of municipal Apt., Jangan-dong	35,631
Lotte E&C	Lotte Castle Grand, Yongsan, Daegu	12,135
Dongil	Dongil Sweety E-mart, Danggam-dong, Busan	12,644
Samsung C&T	Municipal apartment complex 2 under reconstruction project, Jangan-dong	17,301
Byucksan E&C	Sabuk ~ Goan road flood recovery construction	22,998
Hanil Construction	Hanil U&I Apt., Yeonje-gu, Busan	23,457
Donghae Construction	Guinsa Temple historical remains exhibition center, Danyang, Chungcheongbuk-do	19,813
Geonyeong	Residential & commercial B/D, Ilsan, Gyeonggi-do	16,305
Hanil Construction	Gaeseong Middle School, Jin-gu, Busan	37,116
Hyundai E&C	Block C, Seoul Southeastern District Logistics Mall, Jangji-dong	15,000
GS E&C	Reconstruction of Apt. complex 3, Cheolsan-dong, Gwangmyeong-si, Gyeonggi-do	16,974
Hyundai E&C	Hyundai Hill State, Seongbuk-dong, Yongin, Gyeonggi-do	15,990
Hanjin Heavy Industries & Construction	Reconstruction of Gwangyuk, Gwangmyeong, Gyeonggi-do	23,373
Kumho E&C	Expressway No. 10 (Jangheung ~ Gwangyang) construction zone 5, Jeollanam-do	14,825
Namkwang E&C	JCT ramp slope reinforcement, Dangjin, Chungcheongnam-do	11,594
Hyundai E&C, Doosan E&C	Busan Haeundae AID apartment site	28,750

ANCHOR TEST

Anchor Test Service

Samwoo has been conducting various anchor tests, such as performance test, proof test, creep test and lift-off test, domestically and internationally for over 15 years. Our technical know-how built over the years is contributing to development of the related industries and is serving as the foundation for developing and producing anchor products of greater quality.

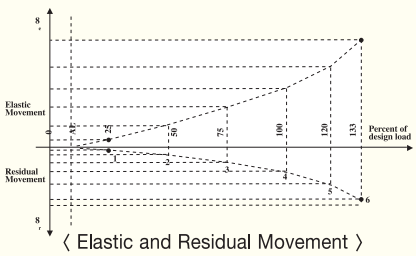


〈 Performance Test 〉

Test Types and Methods

Performance Test

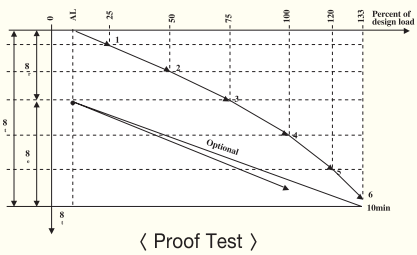
Performance tests involve incremental loading and unloading of a production anchor. The performance test is used to verify anchor capacity, establish load-deformation behavior, identify causes of anchor movement, and to verify that the actual unbonded length is equal to or greater than that assumed in the anchor design. The results of a performance test may also be used to assist in the interpretation of the simpler proof test.



〈 Elastic and Residual Movement 〉

Proof Test

The proof test provides a means for evaluating the acceptability of anchors that are not performance tested. Data from the proof test are used to assess the adequacy of the ground anchor considering the same factors as for performance test data.



〈 Proof Test 〉

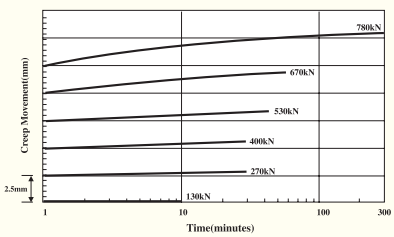
Extended Creep Test

An extended creep test is a long duration test (e.g., approximately 8 hours) that is used to evaluate creep deformations of anchors. These tests are required for anchors installed in cohesive soil having a plasticity index (PI) greater than 20 or liquid limit (LL) greater than 50. For these ground conditions, a minimum of two ground anchors should be subjected to extended creep testing.

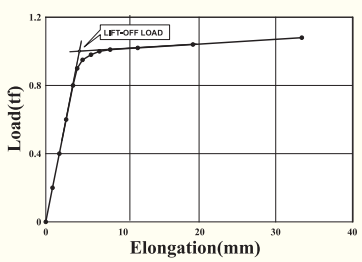
Lift-off Test

The purpose of a lift-off test is to verify the magnitude of the load in the tendon. Lift-off is evidenced by a sudden decrease in the rate of load increase as observed on the jack pressure gauge.

(Reference FHWA-IF-99-015)



〈 Extended Creep Test 〉



〈Lift-off Test〉

PRODUCT & MANAGEMENT

Production Facilities

Samwoo manufacturing facility located in Gimpo-si, Gyeonggi-do has two production lines, one to assemble SW-RCD anchor and SW-Smart Anchor, and another to assemble the SW-PCD and SW-PTF anchors. The computerized manufacturing facility is a semi-automated standardized facility equipped with state of the art equipment resulting in stringent quality control and outstanding quality assurance.

Quality Control

In order to provide customers with products of outstanding quality, Samwoo is regularly conducting thorough quality control test. With test laboratory and diverse testing equipments within our plant, Samwoo is carrying out diverse tests for anchor quality improvement and new product development, such as steel strand yield and break test, wedge grip test, high-pressure waterproof test, test with actual models on testing board and compression strength test.

RESEARCH & DEVELOPMENT

R&D

"Load Transfer of Ground Anchors in Clay"
(Collection of Learned Papers from Korean Geotechnical Society, Vol. 16, No. 3, P 145 ~ 155)

"Compressive type anchor development and performance assessment"
(Collection of Learned Papers from 2001 Spring Academic Forum of Korean Geotechnical Society, P 339 ~ 346)

"Problems of general temporary anchor and improvement direction"
(Collection of Learned Papers from 2003 Spring Academic Forum of Korean Geotechnical Society, P 545 ~ 552)

"Study on drawing characteristics of permanent anchor"
(Master's thesis, Graduate School of Engineering, Hanyang Univ., P2 ~ 12)

"Development of slope reinforcement technology using compressive and distributive anchor" (Project 2005)

"A method of SMART Anchor for a weak ground condition"
(Autumn Academic Forum of Korean Geotechnical Society, Sep. 25 ~ 26, 2009)

"Analysis of the SMART Anchor property in a weak ground condition"
(Autumn Academic Forum of Korean Geotechnical Society, Nov. 27, 2009)

"Distinctive of on-site anchor test SMART manpower removable Anchor for a weak ground condition"
(Autumn Academic Forum of Korean Society of Civil Engineers, Oct. 21 ~ 23, 2009)

"Test results and analysis of the Load Distributive Tensile Friction Anchor removed by manpower"
(The 17th Southeast Asian Geotechnical Conference, Taipei, Taiwan, May. 10~13, 2010)

"Study of ground anchor performance analysis by on-site test"
(The 14th Asian Regional Conference on Soil mechanic and Geotechnical Engineering. Hong Kong, China)

"A study on ground anchor technology for weak ground"
(Korea Association of Professional Engineers in Soil Mechanics & Foundation Engineering / Autumn National Conference 2010, P 237 ~ 246)

"Numerical Analysis of Smart Anchors in Soft Clay"
(Autumn Academic Forum of Korean Geotechnical Society, 2010)

"The properties of load distributive type anchor near the shore"
(Autumn Academic Forum of Korean Geotechnical Society, 2011)

"Formation of grout body with Post grouting and comparison on the performance of the Post-grouted ground anchor"
(Autumn Academic Forum of Korean Geotechnical Society, 2011)

"A case of improvement on uplift resistance anchor system using precast block"
(Autumn Academic Forum of Korean Geotechnical Society, 2012)

"A case study with load-distributive tension type anchor in very weak ground condition"
(Spring Academic Forum of Korean Geotechnical Society, 2013)

Certifications

Through continuous effort for R&D, Samwoo holds a number of domestic and international patents as well as utility model rights. With certifications for ISO9001, research and development center, INNOBIZ(Innovation Business), etc. Samwoo is acknowledged of the quality control and product and technological development competencies both domestically and internationally.

VISION SAMWOO

Samwoo is making ceaseless efforts to be the undisputed leader of ground anchor in the world.

As an anchor specialist, Samwoo, with technological competencies and know-how built over the last 20 years, will further contribute to advancement of anchor technology in Korea. Samwoo will continuously endeavor to have the excellent anchor technology of Korea known all over the world.

Anchor Technology SAMWOO

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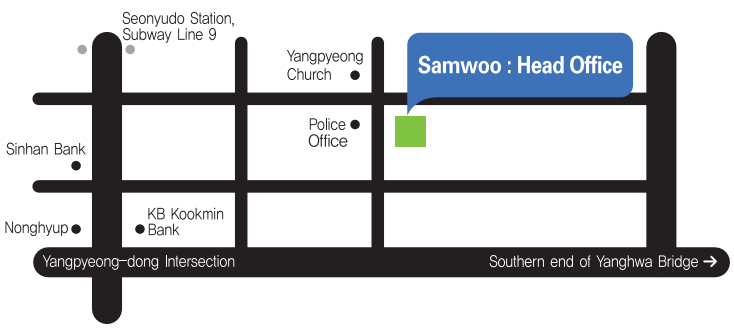
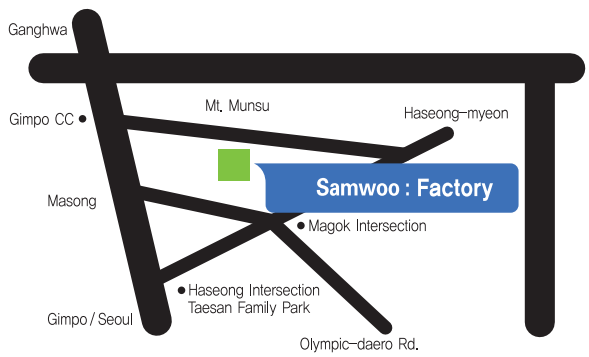
▶ Head Office



▶ Factory



SAMWOO ANCHOR TECHNOLOGY

Anchor Technology
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