



LMK Soil & Rock Anchors (commonly known as Ground Anchors) is part of LMK Post-Tensioning system for the geotechnical applications implementing an easy method for a prompt connection with the ground (soil or rock) being designed in such a way to transfer a force through a system of tendons and anchorages.

The very first applications of ground anchors date back to 1930, however during the last decades have been set in the construction with trends towards a spreading market worldwide.

In nowadays this technology holds a significant position in the Civil Engineering industry with a field of interest in applications of:

- Retaining walls
- Bulkheads
- Slope reinforcement
- Damns, tunnels, vaults and soil stabilization
- Anchoring in structures (foundations piers of bridges etc.)

LMK Ground Anchors implement the experience gained in this field and can meet a wide range of design & construction requirements as well as Int'l specifications & standards.

LMK GROUND ANCHORS

TYPES OF GROUND ANCHORS

➤ Temporary Ground Anchors:

Are those anchors used in construction for a temporary period of time, less than two (2) years. Depending on the design grouting may not be required in the anchor's free length. The strands of free length are not covered with sheath (bare strands). Are commonly used in short time applications like temporary excavations & retaining walls.

➤ Permanent Ground Anchors:

Are those anchors used in construction more than two (2) years. A permanent protection against water corrosion or other chemical substances is necessary (electrochemical anticorrosion protection). For that reason is necessary the anchored & free length section strands to be isolated from the ground using a PE corrugated & plain sheath respectively.

Both types, depending on projects requirements can utilize several levels of protection like overdressed plastic pipes, un-bonded strands, stopper sacks, sealant strips etc.

BASIC CHARACTERISTICS

LMK ground anchors consists of four main having different characteristics based on the requirements of the Design and Projects, i.e. service life, geotechnical data, tensioning force, inspection capability or tensioning force adjustment capacity during anchors service life, etc.



Slope Stabilization



Retaining wall with temporary anchors



Ground anchors applications in Metro construction



Anchor heads



Casted bearing plates & permanent anchor heads



Anchored length with bare strands



Greased & coated strand



Free length with coated strands



Stopper sack filled with grout



Grouting / venting tubes 21/28mm



Spacers



Greased and PE coated strands with spacers



End caps



Coil with ground anchors

➤ Stressing part (strands)

The stressing part consists of a bundle of cables (7-wire strands), the number of which determines the anchoring capacity.

The low relaxation 7-wire strand, commonly 0,6” of nominal diameter, follows the Int’l Standards and specifications of EN 10138 and ASTM A-416.

➤ Anchorage

The anchorage consists of a rectangular bearing plate and an anchor head having conical holes to support the strand’s wedges.

As an alternative, especially in cases of permanent types of ground anchors, a cast-iron round shape bearing unit is used having protection cap for re-tensioning purposes.

Depending on the chosen type of anchorage, the stressing methodology is determined. In the first case the stressing is taking place using a mono-strand jack (one jack for every strand), while in the second case only one jack (multi-strand) can be used stressing simultaneously all strands.

When needed special load cells can be provided in order to monitor the applied stressing force as well as protective caps for the strands free length for re-tension capacity and anti-corrosion protection.

➤ Free length

The section between the embedded into grout - anchored part and the tensioned part up to the anchor head is called free length section. Is the section of the ground anchor which can elongate when stressed.

It is isolated from the grout by a stopper sack or a sealant strip and is surrounded by a plain/corrugated plastic (PE) soft sheath. Strands in this section are protected with grease inside a plastic (PE) tube so as to be unobstructed to elongate when stressed and assure their anticorrosion protection.

The free length section has a variable length depending on the requirements of the design.

It is recommended the free length section to have an adequate length so as to absorb tension, without strongly affecting the final tension load by inducing a gradually decrease of the tensioning force through anchor head and wedges draw-in effect.

Furthermore, should allow the temporary over-stress of strands so as to offset -when needed- the tensioning losses without applying excessive stress in the strands.

➤ Anchoring length

The anchoring length part allows the strands to be anchored into the ground. This anchoring is effected through grouting which embeds the bare strands of the grouting section into the ground, creating a connection bulb.

Upon grout curing, the tensioning force is transferred to the surrounding ground through bonding between the strands, the grout and the soil-rock.

In order to increase the bonding between the strands and the grout, spacers and connectors-links are placed between the strands in constant intervals shaping a zigzag geometry.

A cap (steel or plastic) is placed on ground anchor’s end to facilitate the proper insert in the drilled hole and protect the anchor as well.

The length of the anchored section depends on geotechnical characteristics (sand, gravel, clay, rock etc.) as well as the required by the design working load.

ANCILLARIES

➤ Stopper Sack

In some cases, when the grouting of the anchored length part should be effected under pressure, a stopper sack is used (common length of 1,00 m). This sack is placed between the free and anchored section of the anchor and when is grouted (prior of grouting the anchored section), is stabilized around the ground anchors and hole’s perimeter by creating a separation diaphragm between the free and anchored sections.

The under pressure grouting is taking place securing as much as possible the grouting of the surrounding area for a proper anchoring. It is commonly used in gravel soils.

➤ Grouting & venting tubes

Are plastic tubes for grouting and venting purposes.

➤ Spacers

Are plastic open or closed type having grouting and venting tubes holes assuring the proper space and central position of strands.

➤ Front cap

Made of steel or plastic is placed on the front part of ground anchor to protect and facilitate the easy insert of the anchor into the drilled hole.

➤ Corrugated & plain sheath

Made of plastic the corrugated sheath covers the hole length of anchored section, while the plain sheath covers the free section (cases of permanent anchors). Alternatively, corrugated sheath can also be used in the free length.

1. Installation

Ground anchors are placed in the predefined position with simply insertion taking into consideration the proper alignment and anticorrosion protection of anchor. In loose soils the insertion of anchor is taking place using a steel tube as a guide, which is removed immediately after the placement of ground anchor. Spacers for alignment purposes can also be used.

2. Grouting

The mix design follows design specifications. A typical mix could be:

- Cement type CEM I 42,5
- Potable water at ratio W/C 0,35-0,70 (per weight). The ratio W/C depends on the type of soil.
- Expanding admixture (if required by design)

The applied grouting methodology depends on the type of soil as well as the groundwater table elevation. The grouting is effected using a typical grouting pump through the grouting and venting tubes of the ground anchor.

3. Tensioning

The stressing follows the WMS of LMK PT system stressing procedure, i.e.:

- Stressing pump
- Mono-strand jacks or multi-strand jacks depending on the type of anchorage
- Pressure distributors & gauges

The predefined pressure is applied in phases measuring the elongation of strands.

4. Testing & monitoring

Usually at permanent types of ground anchors load cells are placed so as to monitoring the stressing force during the working life of anchor.

For this reason the free length of the strands is covered by a protection cap for anti-corrosion protection as well as for future tensioning.

Depending on the design requirements suitability tests (bonding of soil & grout) and acceptance tests (loading test) according to Int’l standards may take place.



Corrugated & plain PE sheaths



Drilling machine



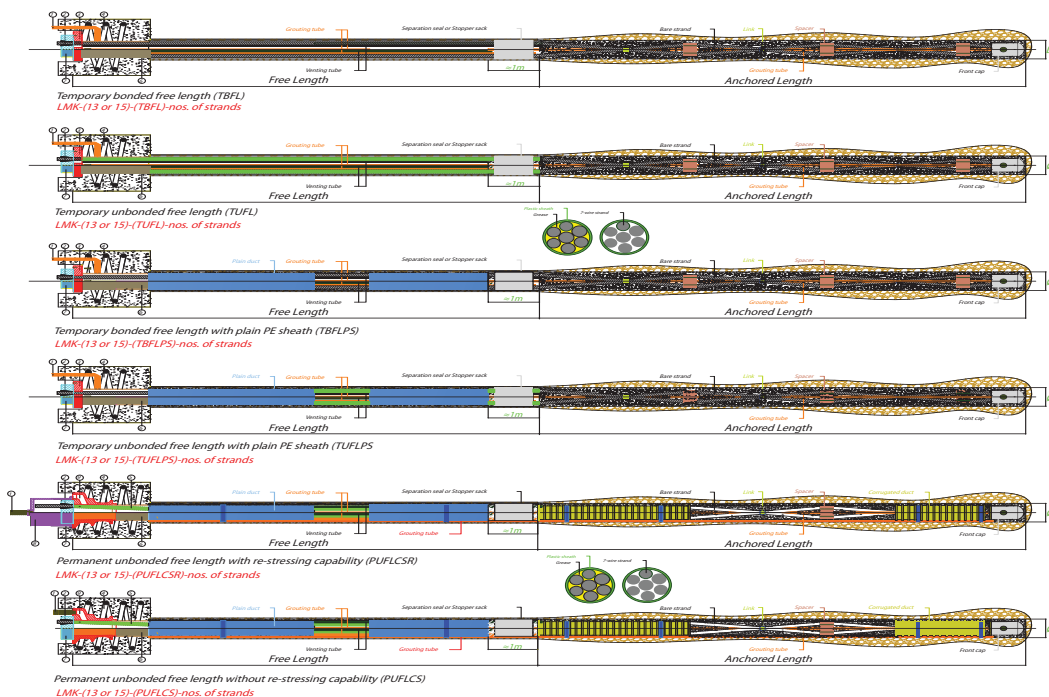
Stressing of ground anchor



Load cell



Protection cap



LEGEND: 1. Grouting tube | 2. Wedges | 3. Steel bearing plate | 4. Spiral | 5. Coated strand | 6. Steel tube | 7. Anchor head | 8. Grouting cap | 9. Cast bearing plate

LMK SOIL & ROCK ANCHORS

Temporary Ground Anchors






Anchor Size-Strands Nos.		2-4	6	7	9	10	12	13	18	20
	ΦA	135	135	150	175	175	185	185	217	235
	B	52	52	52	60	65	70	70	90	90
	C x C	260	260	280	310	330	360	370	440	460
	D	36	36	36	40	40	50	50	60	60
	ΦE	95	95	108	130	135	135	135	155	170
	ΦF	127	127	127	146	146	159	159	180	194
	Lmin	400	400	400	500	500	600	600	700	700
	ΦG	110	110	110	130	130	140	140	150	165
	H	30	30	30	35	35	38	38	40	40
	ΦJ	72	72	72	78	86	94	104	110	110
	K	195	195	195	195	195	205	205	205	205
Drilling Hole	Φmin	140	140	140	160	160	170	170	190	200

Table – 1. All dimensions in mm Anchors of bigger size or special design can also be manufactured upon request.

Permanent Ground Anchors






Anchor Size-Strands Nos.		2	3	4	6	7	9	11	12	13	18	20
	ΦB	86	91	102	126	126	146	166	166	176	206	226
	C	50	50	50	52	53	55	58	60	63	75	80
	ΦA	140	140	140	180	180	210	225	225	255	280	310
	D	125	125	125	170	170	190	230	230	250	325	325
	ΦF	127	127	127	127	127	146	146	159	159	180	194
	Lmin	400	400	400	400	400	500	500	600	600	700	700
	ΦG	110	110	110	110	110	130	130	140	140	150	165
	H	30	30	30	30	30	35	35	38	38	40	40
	ΦJ	72	72	72	72	72	78	86	94	104	110	110
	K	195	195	195	195	195	195	195	205	205	205	205
Drilling Hole	Φmin	140	140	140	140	140	160	160	170	170	190	200

Table – 2. All dimensions in mm Anchors of intermediate size are also available.

TYPICAL GROUND ANCHOR METHODOLOGY

Design Data

- Type of Anchor (temporary or permanent)
- Free & anchored length
- Nos. of strands
- Axis inclination (upward-downward)

TYPICAL CALCULATION EXAMPLE

-Typical strands characteristics:

Nominal Dia:	Nominal Section:	Strand Quality:
15,2 mm	139 mm ²	170/190 Kg/mm ² (1670/1860 N/mm ²)

-Safety coefficient against breaking load: $\sigma = 1,5$ (as specified)

-Maximum allowable loads:

Maximum allowable stress per strand: $\sigma_1 = 1670 \text{ N/mm}^2 / 1,5 \approx 1113 \text{ N/mm}^2$

Maximum allowable load per strand: $N_s = 139 \text{ mm}^2 \times 1113 \text{ N/mm}^2 \approx 155 \text{ KN}$

-Number of strands needed:

Working load by the Design 400/500 KN $n = 400 \text{ KN} / 155 \text{ KN} = 2,6$ strands
 $= 3, n = 500 \text{ KN} / 155 \text{ KN} = 3,2$ strands $= 4$

The fabrication is taking place in indoor area by specialized staff as per the following typical phases:

- Strands cutting as per the predefined length
- Coating of free length with grease and PE sheath
- Cutting & installation of grouting & venting tubes
- Installation of spacers and links at anchored length.
- Separation of anchored length using sealant strip
- Free length overdressing with PE sheath. Depending on the type of anchor overdressing of anchored length with corrugated PE sheath or/ and installation of stopper sack
- End cap installation
- Anchor coiling (dia. of 2m) for transportation purposes

Anchor is coming along with anchor head, wedges and bearing plate.

Supply and application of specialized products for bridge, road & building construction industry, including the design, construction, installation and supervision of these applications.

Specialized Engineering services such as design, maintenance & retrofitting of structural elements requiring sophisticated know-how.

E: info@hiscs.gr, www.hiscs.gr

HiSCS S.A.
HIGHWAY SPECIAL CONSTRUCTION SYSTEMS