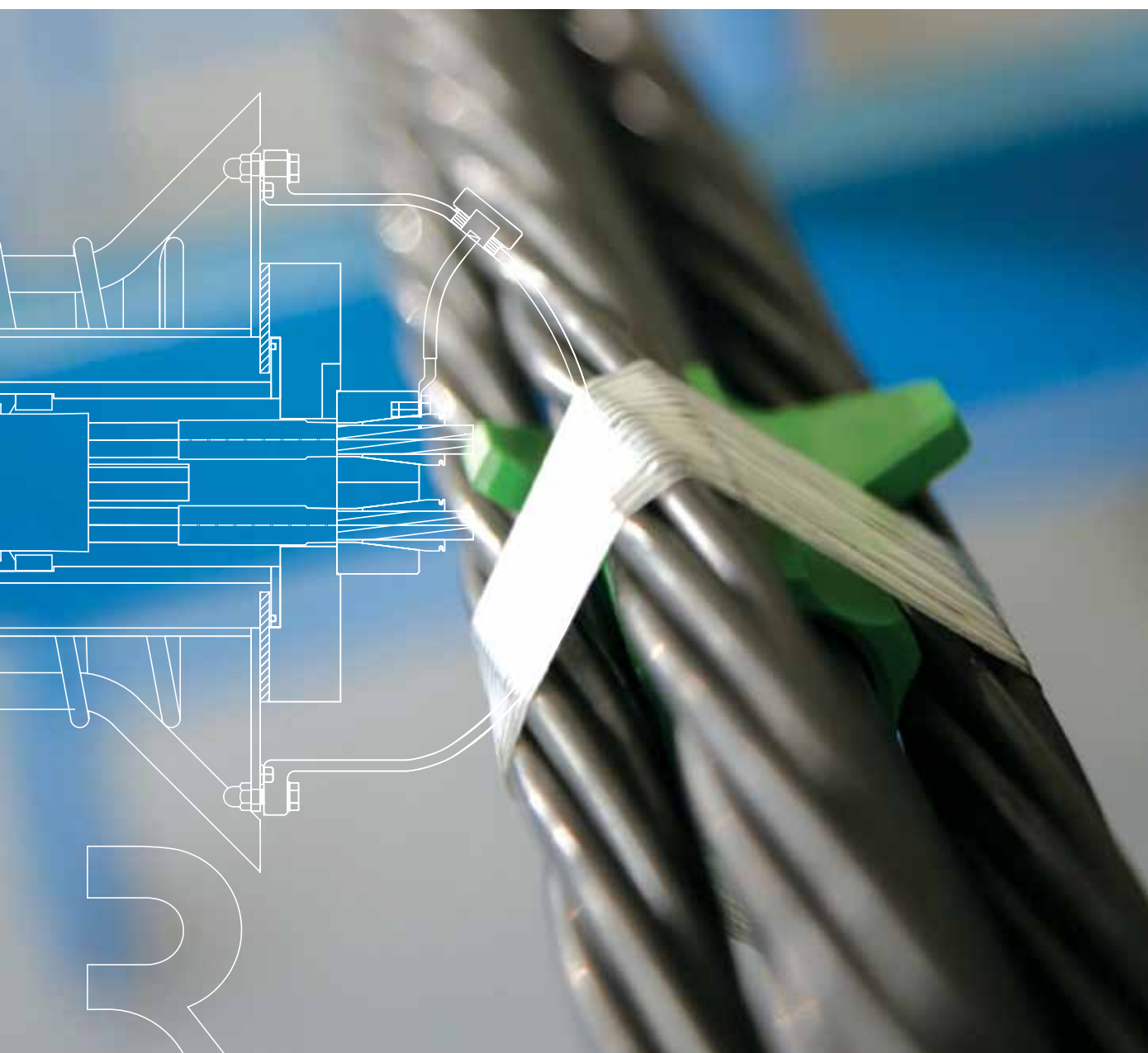




# TRAJNO PREDNAPETO GEOTEHNIČKO SIDRO TPGS RAFAEL 10



PERMANENT PRESTRESSED  
GROUND ANCHOR  
TPGS RAFAEL 10



## 01 TRAJNA KVALITETA

Poduzeće Rafael je specijalizirani stručnjak za obavljanje građevinskih usluga na području:

- sanacije klizišta,
- željezničkih i cestovnih radova,
- hidro gradnje,
- proizvodnje i ugradnje geotehničkih sidara.

Dobre odnose sa partnerima i klijentima gradimo već od 1992 godine. Svakom projektu pristupamo celovito te pružamo inovativna rešenja, usluge i najkvalitetnije materijale.

2010 godine smo na području geotehnike postali certificirani proizvođač geotehničkih sidara. Našu kvalitetu dodatno odlikuju i drugi dobiveni slovenski i međunarodni certifikati: certifikat kvalitete 9001, slovenski tehnički sporazum (Slovenska tehnička suglasnost – STS), europski tehnički sporazum.

Svoja iskustva i poslovanje konstantno razvijamo i nadgrađujemo sa novim znanjem, inovativnim rešenjima i tehnološko naprednom opremom, što nam omogućuje uspeh i na stranim tržištima.

### POS LANSTVO

*Stvaranje sigurnog suživota sa prirodom.*

Rafael je gradbeni specijalist za područje željezničkih, cestovnih, vodenih i zemljanih gradnji:

- sa našim gradnjama je željeznički promet brži i sigurniji,
- sa sanacijama klizišta umirimo sile prirode i kroz ugradnju geotehničkih sidara površinu pripremimo za učinkovito korištenje,
- sa hidro gradnjama omogućujemo upravljanje vodne energije i njeno sigurno korištenje,
- objektima dajemo prirodni oblik u skladu s okolinom u kojoj se nalaze.

### VIZIJA

Rafael je u sljedećih deset godina najcjjenjeniji slovenski specijalist za željezničku, cestovnu i hidro gradnju te sanaciju klizišta i najveći dobavljač geotehničkih sidara na području jugoistočne Evrope.

### VRIJEDNOSTI

- točnost
- pouzdanost
- inovativnost
- povjerenje
- sigurnost



## PERMANENT QUALITY

The Rafael Company provides their partners quality services in the fields of:

- rehabilitation of avalanches,
- railway and road constructions,
- hydro-constructions,
- anchoring.

Since 1992 a good relationship with our business partners has been based on the overall approach to every single project, as well as on the assurance of innovative solutions, services and the utilization of top-quality materials.

In the year 2010 the Rafael Company became a certified manufacturer in the field of geo-technical anchors. Our excellence is also proved by attained nationally and internationally recognised certificates: the ISO 9001, the Slovene Technical Approval (STS), and the European Technical Approval (ETA).

Our experiences and business activities are regularly improved and implemented by new knowledge, innovative solutions, and technologically advanced equipment which enable our successful launching on to the international markets.

### MISSION

Creating a safe co-existence with nature.

The company is an expert in the field of railway, road, hydro and ground constructions:

- our constructions make railway traffic faster and safer,
- we manage to fight the forces of nature with the rehabilitation of avalanches, and make the ground surface ready for an effective usage by the in-building of the ground anchors,
- our hydro-constructions enable dealing with water energy and using it in a safe way,
- final constructions are given a natural appearance matching perfectly with the environment they belong to.

### VISION

In the next ten years, the Rafael Company is the most recognised Slovene expert in the field of railway, road and hydro constructions, rehabilitation of avalanches, and the biggest manufacturer of geo-technical anchors in the south east of Europe.

### VALUES

- precision
- reliability
- innovativeness
- trust
- safety

## O2 INOVATIVNI RAZVOJ SIDRA

Vlastiti razvoj, neprestano uvođenje novih i inovativnih rješenja te korištenje naprednih tehnologija su u poduzeću Rafael vodili do uspostave vlastite proizvodnje trajno prednapetih, električno izoliranih geotehničkih sidara (TPGS RAFAEL 10).

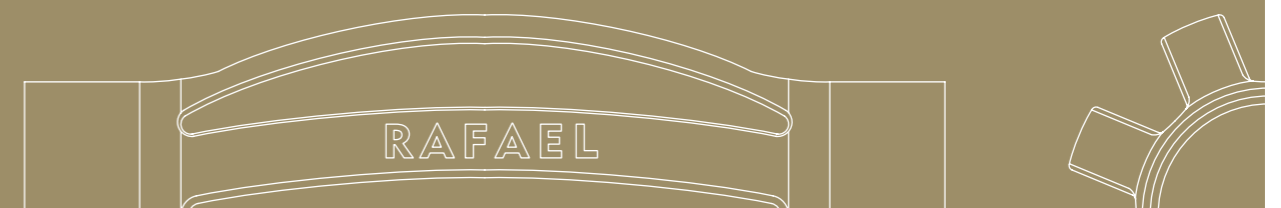
Upotreba tih sidara je primarno namijenjena zaštiti nestabilnih padina ili sličnih kamenih konstrukcija, jer su sidra Rafael jedan od glavnih građevinskih elemenata, koji zbog upotrebe greda iz visoko vrijednog čelika trajno prenose nateznu silu sa sidrene gradbene konstrukcije u tlo. Trajni životni vek sidra znači, da je njegova upotreba duža od dvije godine – jednaka životnom veku sidrenog objekta.

Sa sidrenjem postizemo stabilizaciju padine ili drugih konstrukcija bez većih pomicanja usidrenog objekta. Sidra Rafael su namijenjena za upotrebu:

- iskopa,
- ukopa,
- iskopa za izgradnju tunela,
- sidrenja mostova,
- sanacije klizišta i padina,
- hidro gradnji,
- željezničkih gradnji,
- ostalog.

Sidra Rafael se razlikuju u načinu upotrebe:

- **Osnovna ili konstrukcijska sidra** su dio usidrene konstrukcije.
- **Testna sidra** su namijenjena testiranju sidra do rušenja. Opremljena su sa dodatnim čeličnim gredama i služe testiranju vanjskih opterećenja na području testnog sidra – dio usidrenog objekta koji služi konačnom verificiranju projektnog rješenja sidrenja.
- **Kontrolna sidra** omogućavaju obavljanje dodatnih testiranja opterećenja sidra u bilo koje vrijeme.
- **Sidra za mjerenje** su opremljena sa uređajem za mjerenje sile sidra (»dinamometar«). Provjera sile sidra je moguća u svakom trenutku, čak i na daljinu (npr. iz ureda).





## ADVANCED DEVELOPMENT OF ANCHORS

The proper development, constant search for new, innovative solutions and the involvement of the advanced technology, have led the Rafael Company to the establishment of its own production of permanent pre-stressed, electrically insulated geotechnical ground anchors (TPGS RAFAEL 10).

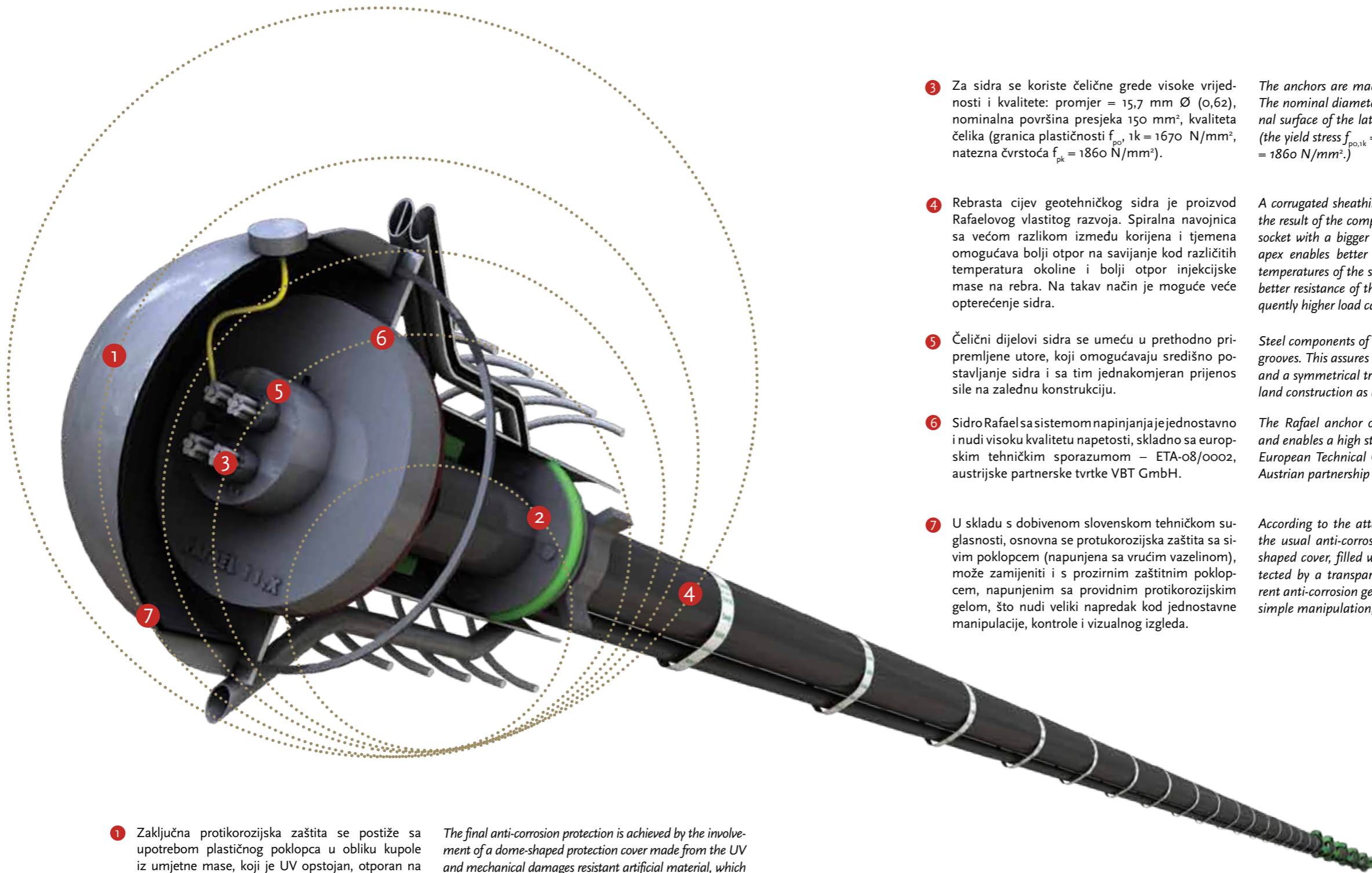
The involvement of these anchors is primarily designed for the protection of unstable inclines or similar constructions in aggregates and soil ground since the Rafael anchors are one of the vital supporting construction elements which due to high quality steel strands permanently withstand the stress of stretching from the ground-anchored construction. A permanent life expectancy of the anchor would mean that its usability overcomes two years and can match the life-expectancy of the anchored structure.

The process of anchoring enables high stabilisation (or the improvement of the state of deformation) of the incline or of other constructions without any necessary movements of the anchored structure. The Rafael anchors are suitable for the protection of:

- building pit,
- incision with support walls,
- excavations at tunnel constructions,
- anchoring of bridging structures supports,
- rehabilitation of avalanches, landslides, and embankments,
- hydro-constructions,
- railway constructions,
- other services.

The Rafael anchors differ from each other according to the way of their use:

- **Basic or construction anchors** are parts of an anchoring construction.
- **Testing anchors** are intended for testing purposes of anchors till pulling-down. They are equipped by an additional strand and are supposed to control the outside load capacity of the area of the testing anchor – a part of an anchored structure, which serves for the final verification of the anchor project solution.
- **Control anchors** enable the implementation of additional load capacity testing at any time.
- **Measuring anchors** are equipped by an anchor force measuring device (a measuring cell or dynamometer); the control over anchoring forces is able to be implemented at any time, even from a longer distance (i.e., from an office).



1 Zaključna protikorozijska zaštita se postiže sa upotrebom plastičnog poklopca u obliku kupole iz umjetne mase, koji je UV opstojan, otporan na mehanička oštećenja i oštećenja zbog vremenskih uvjeta (magla, soljenje cesta). Namještanje kupole je jednostavno, jer nije potrebno dodatno bušenje rupa za ugradnju. Zaštitni poklopac je sive boje – u skladu sa betonskom konstrukcijom.

*The final anti-corrosion protection is achieved by the involvement of a dome-shaped protection cover made from the UV and mechanical damages resistant artificial material, which remains if exposed to fog, salt and coastline weather conditions. The placement of the dome is simple, no additional openings are required to be drilled for the means of fixing. The protection cover is of gray colour which matches well with the concrete construction.*

2 Dvojno zaštitno tijesnilo glave sidra sa dodatnim drenažnim otokom štiti glavu sidrapred pronicanjem vode. Tijesnila su rezultat razvoja Rafaela i pružaju visoku razinu tiješnjenja okruglih i elipsastih zaštitnih cijevi sidra.

*Double protection-sealing of the anchor head with an additional drain protects the anchor head from the penetration of hinterland water. The seals are the result of the Rafael Company development and enable a high-level sealing of circular and elliptic protection tubes of the anchor.*

3 Za sidra se koriste čelične grede visoke vrijednosti i kvalitete: promjer = 15,7 mm Ø (0,62), nominalna površina presjeka 150 mm<sup>2</sup>, kvaliteta čelika (granica plastičnosti  $f_{po,1k} = 1670$  N/mm<sup>2</sup>, natezna čvrstoća  $f_{pk} = 1860$  N/mm<sup>2</sup>).

*The anchors are made from high quality steel strands: The nominal diameter Ø = 15,7 mm (0,62"), the nominal surface of the lateral section 150 mm<sup>2</sup>, steel quality (the yield stress  $f_{po,1k} = 1670$  N/mm<sup>2</sup>; tensile strength  $F_{pk} = 1860$  N/mm<sup>2</sup>.)*

4 Rebrasta cijev geotehničkog sidra je proizvod Rafaelovog vlastitog razvoja. Spiralna navojnica sa većom razlikom između korijena i tjemena omogućava bolji otpor na savijanje kod različitih temperatura okoline i bolji otpor injekcijske mase na rebra. Na takav način je moguće veće opterećenje sidra.

*A corrugated sheathing involved in the Rafael anchor is the result of the company's proper development. A spiral socket with a bigger difference between the thread and apex enables better resistance to bending at different temperatures of the surrounding environment, as well as better resistance of the injection mass to ribs and consequently higher load capacity of the anchor in the hole.*

5 Čelični dijelovi sidra se umeću u prethodno pripremljene utore, koji omogućavaju središnje postavljanje sidra i sa tim jednakomjeran prijenos sile na zalednu konstrukciju.

*Steel components of the anchor are arranged into ready grooves. This assures the central setting-up of the anchor and a symmetrical transfer of the force on to the hinterland construction as a result.*

6 Sidro Rafaela sa sistemom napinjanja je jednostavno i nudi visoku kvalitetu napetosti, skladno sa europskim tehničkim sporazumom – ETA-o8/0002, austrijske partnerske tvrtke VBT GmbH.

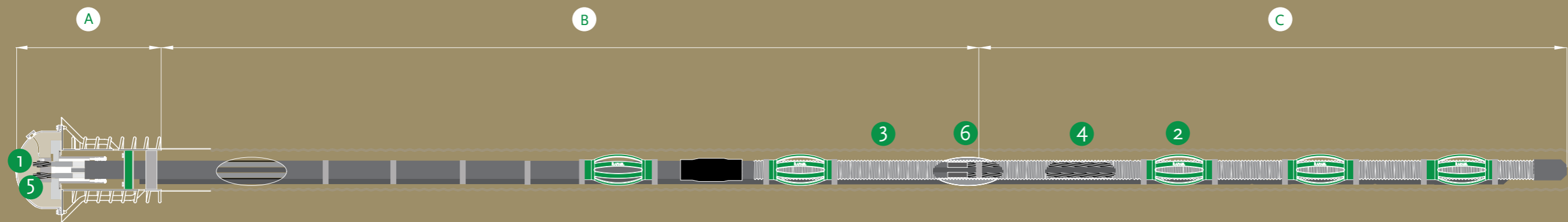
*The Rafael anchor of a single-stress system is simple and enables a high stress quality in compliance with the European Technical Conformity ETA – o8/0002 of the Austrian partnership company VBT GmbH.*

7 U skladu s dobivenom slovenskom tehničkom suglasnosti, osnovna se protukorozijska zaštita sa sivim poklopcem (napunjena sa vrućim vazelinom), može zamijeniti i s prozirnim zaštitnim poklopcem, napunjenim sa providnim protikorozijskim gelom, što nudi veliki napredak kod jednostavne manipulacije, kontrole i vizualnog izgleda.

*According to the attained Slovene Technical Approval, the usual anti-corrosion protection with a gray dome-shaped cover, filled with hot vaseline, may also be protected by a transparent protection cover and transparent anti-corrosion gel which means a huge progress at a simple manipulation, control and visual outlook.*

Rafaelovi proizvodi su proizvedeni u skladu sa propisima Republike Slovenije – Zakon o gradbenim proizvodima. Naš brz odziv na želje i potrebe klijenata omogućava kratke nabavne rokove sidara. U primjerima njihovog dužeg skladištenja, zbog zaštite i sprečavanja oksidacije golih čeličnih greda u veznom dijelu, unutrašnjost sidra zaštitimo sa inernim plinom.

*The Rafael products are manufactured according to the Regulative of the Republic of Slovenia – Construction Products Act. The company's prompt reaction to the customers' wishes and requirements assures quick delivery of the anchors. In case of a planned long-term storage, the inside of the anchor is protected by inert gas in order to prevent the oxidation of bare steel strands in the fixed anchor length.*



- A** Glava sidra – silu iz veznog dijela prenosi na konstrukciju  
*Anchor head – transmits the force of the fixed anchor length to the structure*
- B** Slobodni dio sidra – prenosi silu iz veznog diela na glavu sidra  
*Free anchor length - transmits the force of the fixed anchor length to the anchor head*
- C** Vezni dio sidra – nateznu silu prenosi na zalede  
*Fixed anchor length - tensile force is transmitted to the rear*

Tabelarni prikaz prikazuje usporedbu sidra Rafael u ovisnosti od broja w greda (opterećenje greda je određeno u skladu sa slikom 12 Standard SIA 267/1).

The table shows the comparison between the Rafael anchors according to the number of steel strands (strand loadings are defined in compliance with the Figure 12 of SIA 267/1 standard).

Broj greda Number of strands	$A_p$ [mm <sup>2</sup> ]	$P_{pk}$ [kN]	$P_{p,max}$ [kN]	$P_{pv,max}$ [kN]	$P_{o,min}$ [kN]	$P_{o,max}$ [kN]	$P_{min}$ [kN]	$P_{max}$ [kN]
2	300	558	419	474	167	335	167	391
3	450	837	628	711	251	502	251	586
4	600	1116	837	949	335	670	335	781
5	750	1395	1046	1186	419	837	419	977
6	900	1674	1256	1423	502	1004	502	1172
7	1050	1953	1465	1660	586	1172	586	1367

- $A_p$  površina prečnog prereza sidra / *ateral section surface*
- $P_{pk}$  natezna čvrstost pramena sidra / *tensile strength of an anchor strand*
- $P_{p,max}$  maksimalna dozvoljena sila kod testiranja napetosti / *maximal testing force of test-stressing (0,75 Ppk)*
- $P_{pv,max}$  maksimalna dozvoljena sila kod testiranja sidra / *maximal testing force of anchor-testing (0,85 Ppk)*
- $P_{o,min}$  minimalna sila zaklinjanja / *minimum force of wedging (0,30 Ppk)*
- $P_{o,max}$  maksimalna sila zaklinjanja / *maximum force of wedging (0,60 Ppk)*
- $P_{min}$  minimalna sila tokom životne dobi sidra / *minimum force of an anchor in its life-expectancy (0,30 Ppk)*
- $P_{max}$  maksimalna sila tokom životne dobi sidra / *maximum force of an anchor in its life-expectancy (0,70 Ppk)*



## 03 NAPREDNA PROIZVODNA ZNANJA

Napredne tehnologije i suvremeni trendovi na trgu geotehničkih sidara zahtijevaju konstantan razvoj, napredak i nove, inovativne ideje koje našim klijentima pružaju cjelovita i kvalitetna rješenja.

Proizvodnja sidara Rafael je stacionirana u vlastitim prostorima, pod budnim okom profesionalnog tima sa dugogodišnjim iskustvom i sa najmodernijom kompjuteriziranom opremom za namještanje čeličnih greda.

Kompjutersko upravljanje mašinske opreme jamči najvišu razinu za postizanje konstantne kvalitete proizvoda i usluga, koje nadziremo i proveravamo preko uspostavljenog sustava internih kontrola – pod stalnim nadzorom ovlaštenog organa (ZAG Slovenija) – te u skladu sa odredbama certifikata 9001.

Željama i potrebama naših klijenata se posvećujemo celosti i individualno, zato je svaki proizvod napravljen po narudžbi. Do nameštanja proizvode čuvamo u sigurnosnim čeličnim kavezima, što nam omogućava najvišu razinu zaštite pred oštećenjem.

Naš rad odlikuju inovativni pristup u rješavanju građevinskih problema, bogato iskustvo i stručnost, napredni razvoj, visoku kvalitetu, praćenje slovenskih i europskih standarda te dugoročni partnerski odnosi.



Slovenska tehnička  
suglasnost STS-10/0038



Europska tehnička  
suglasnost ETA-08/0002



Slovenian technical  
approval STS-10/0038



European technical  
approval ETA-08/0002

## INNOVATIVE PRODUCTION KNOWLEDGES

*Advanced technologies and contemporary trends from the market of geo-technical anchors require a constant development, progress and new, innovative ideas which provide our customers with complex and quality solutions.*

*The production of the Rafael anchors is carried out in the venue of the company, under the surveillance of the professional team with long standing experiences, and with the most on-line computerised steel strands-setting equipment.*

*The computerised equipment assures a constant achievement of the top-quality of products and services that are followed and tested with the system of internal control under a permanent supervision of the accredited body (ZAG Slovenia), as well as in compliance with the 9001 certificate provisions.*

*Our customers are treated comprehensively and individually. For this reason, each product is produced by request and stored in protection steel cages until its setting-up, thus enabling as good protection from eventual damages as possible.*

*Our work is distinguished for its innovative approach to the sorting out the problems in the building trade, rich experiences, professional knowledge, advanced development and high quality, matching both the national and European standards, as well as long-lasting partnerships.*





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ISO 9001  
BUREAU VERITAS  
Certification

**ZAG**  
CORPORATION

**EOTA**

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