Organizatori

SVEUČILIŠTE U ZAGREBU GRAĐEVINSKI FAKULTET UNIVERSITY OF ZAGREB

SVEUČILIŠTE U ZAGREBU GRAĐEVINSKI FAKULTET UNIVERSITY OF ZAGREB FACULTY OF CIVIL ENGINEERING

SVEUČILIŠTE U SPLITU, FAKULTET GRAĐEVINARSTVA, ARHITEKTURE I GEODEZIJE

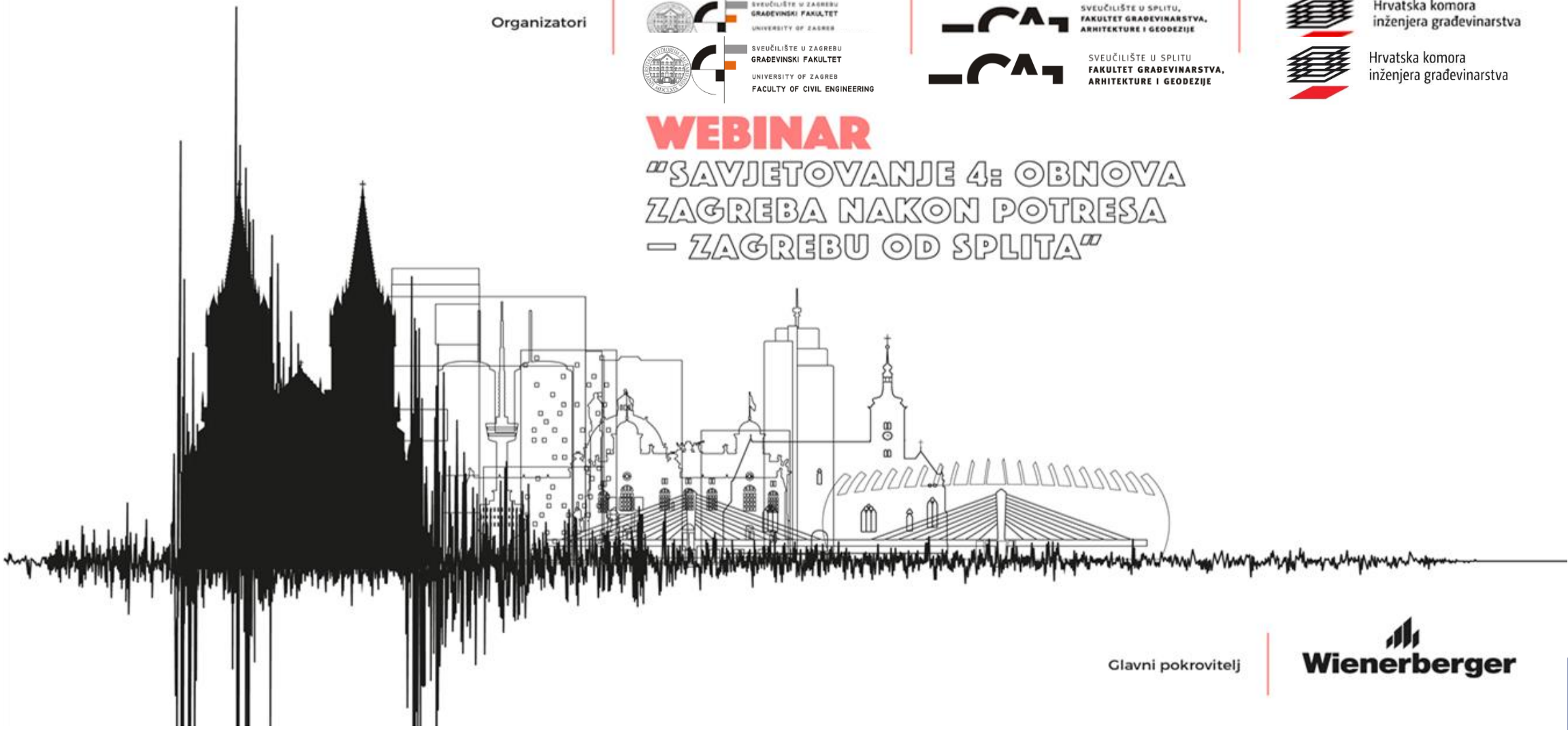
SVEUČILIŠTE U SPLITU FAKULTET GRAĐEVINARSTVA, ARHITEKTURE I GEODEZIJE

Hrvatska komora inženjera građevinarstva

Hrvatska komora inženjera građevinarstva

# WEBINAR

## "SAVJETOVANJE 4: OBNOVA ZAGREBA NAKON POTRESA – ZAGREBU OD SPLITA"



Glavni pokrovitelj

Wienerberger

# ISKUSTVA I EKSPERIMENTALNA ISTRAŽIVANJA U VEZI SEIZMIČKE SANACIJE ZIDANIH ZGRADA

**mr.sc.Berislav Borovina, dipl.ing.građ.**
**Miljenko Vučić, mag.ing.aedif.**
**SPEGRA d.o.o.**
Split, Hrvatska

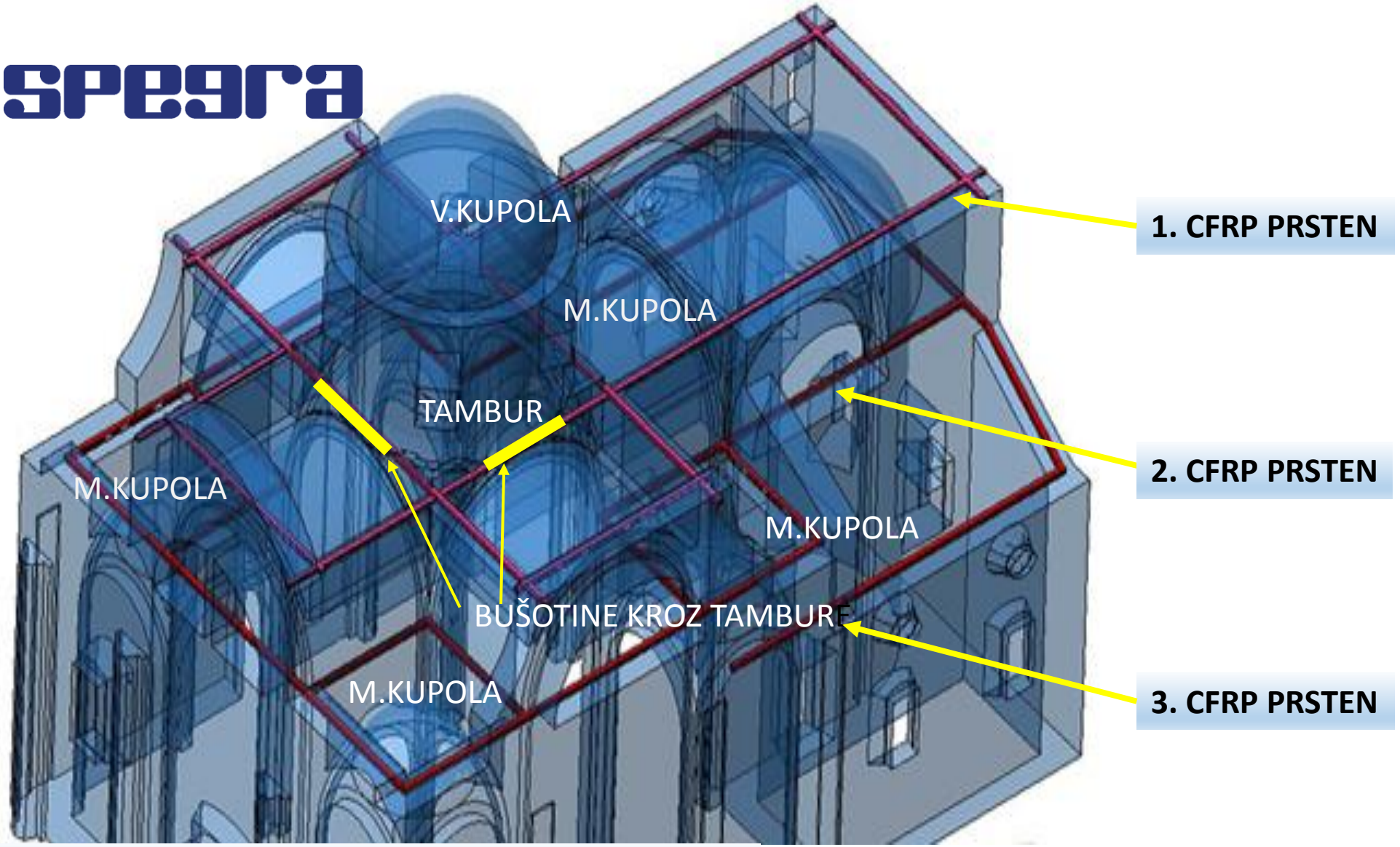
# SANACIJA KAMENOM ZIDANIH GRAĐEVINA S POPISA SPOMENIČKE BAŠTINE

www.spegra.hr

# SVETI VLAHO DUBROVNIK

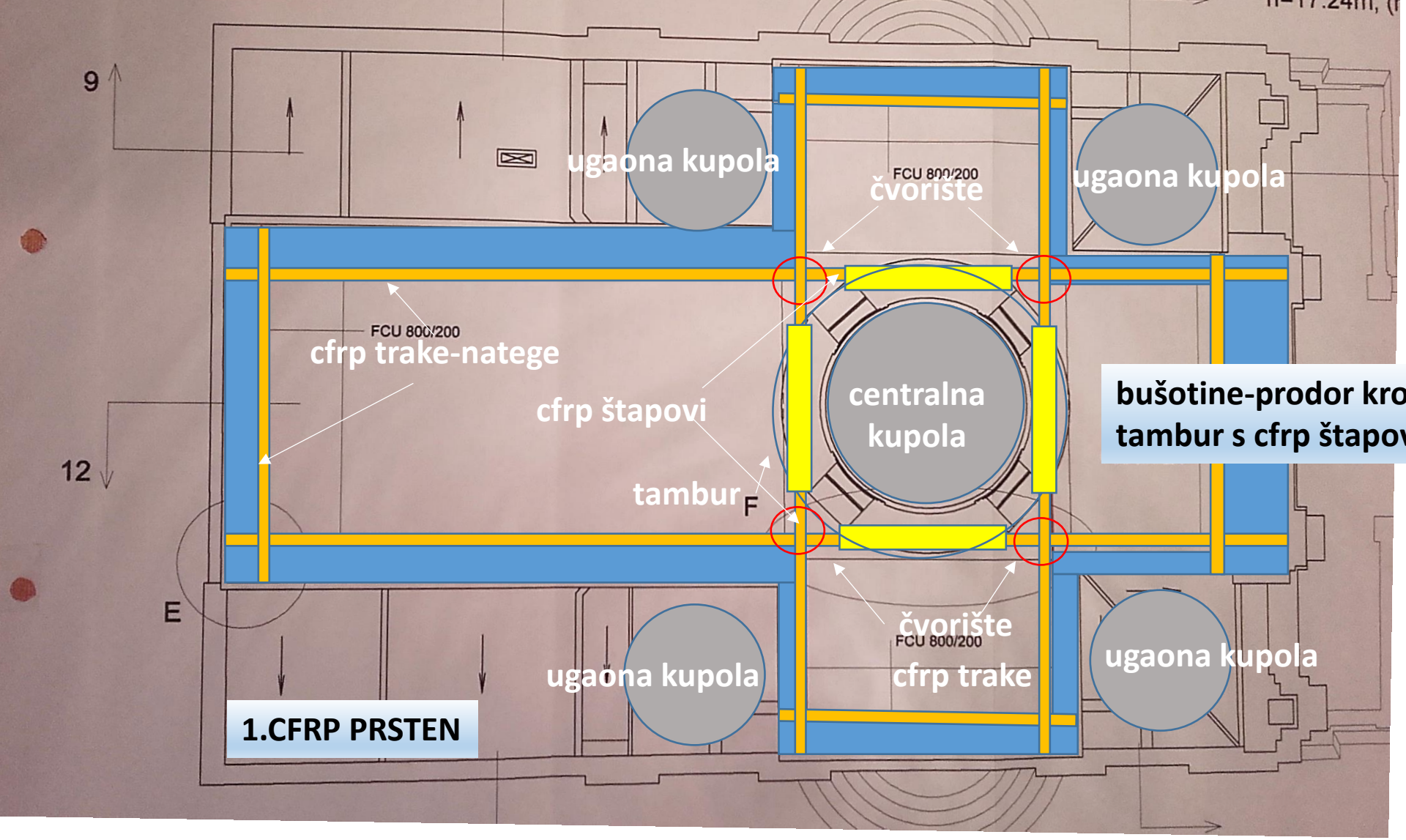
## OJAČAVANJE KONSTRUKCIJE SA FRP KOMPOZITIMA

www.spegra.hr

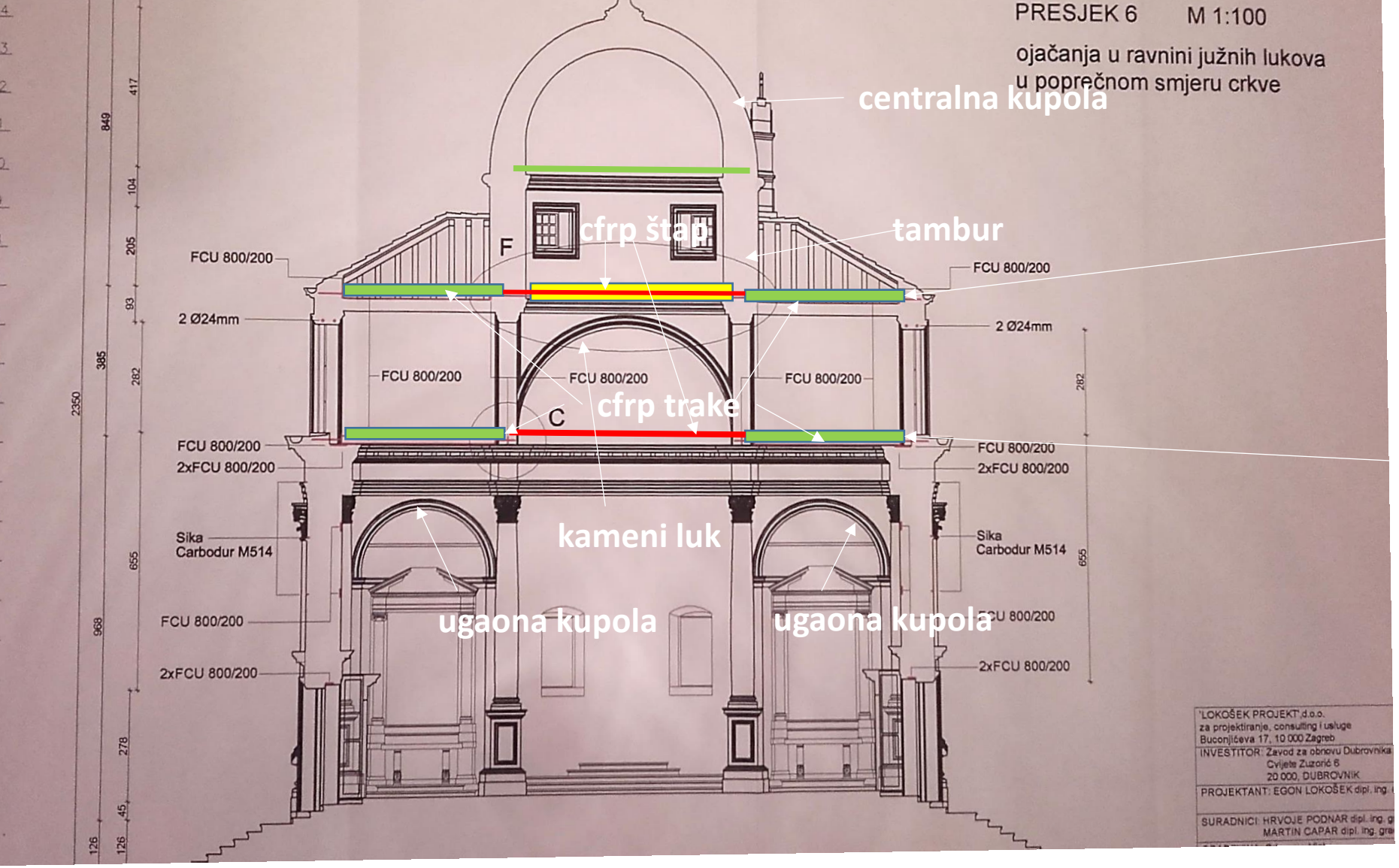



**PLAN UGRADNJE CFRP POJAČANJA U TRI RAZINE**

www.spegra.hr



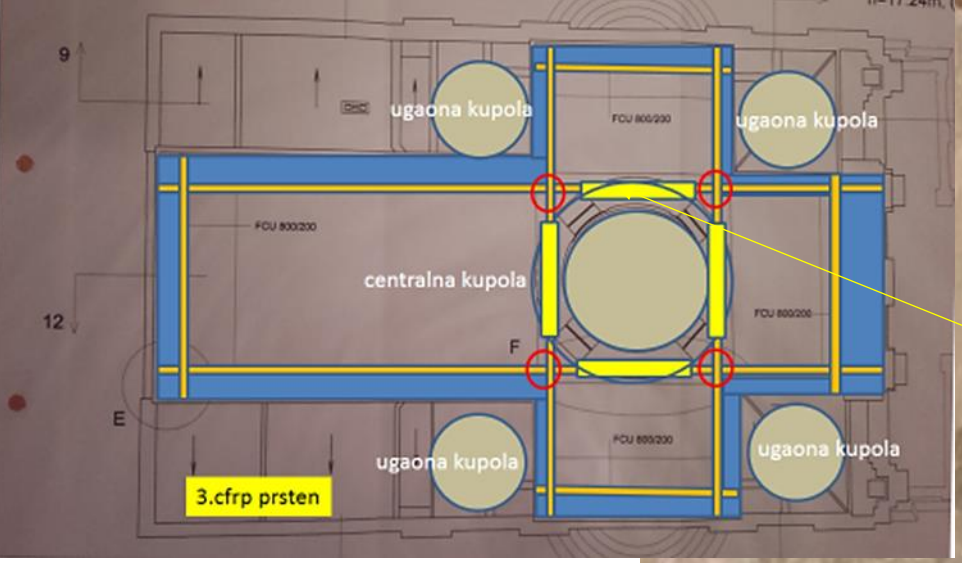

## OPIS DETALJA CFRP POJAČANJA - 1. RAZINA




**1. CFRP PRSTEN**

**2. CFRP PRSTEN**

www.spegra.hr

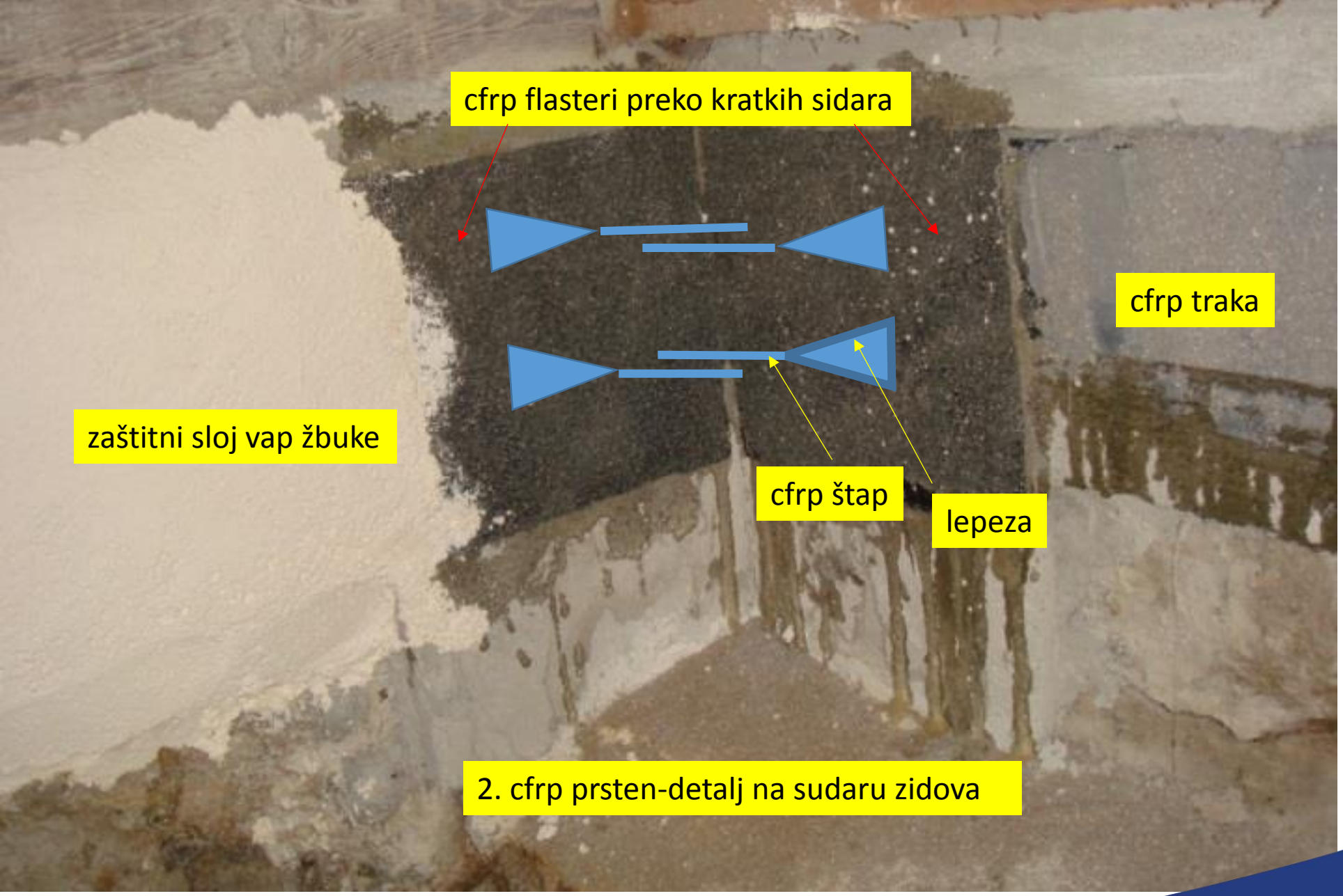



kratka sidra

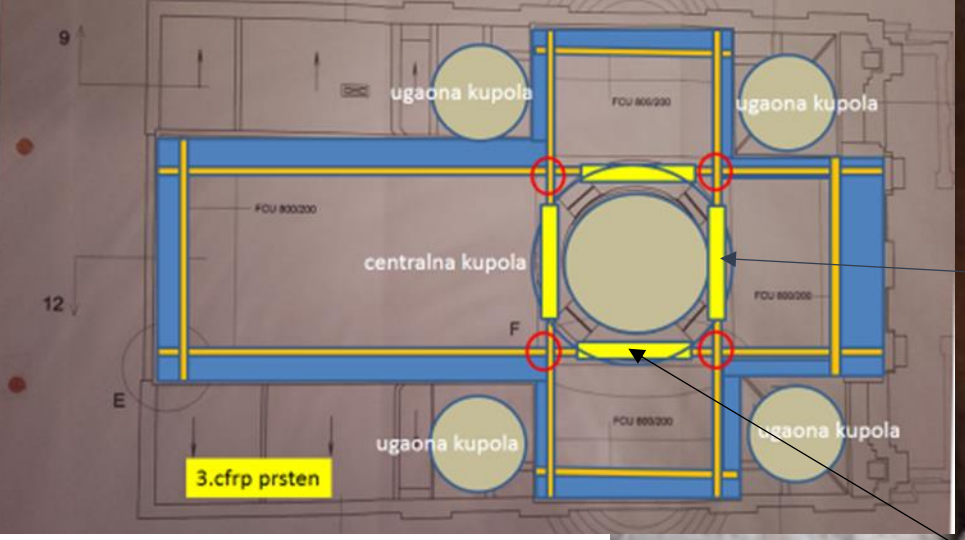
cfrp prsten

2. cfrp psten

www.spegra.hr




2. cfrp prsten-detalj na sudaru zidova




cfrp štapovi

zid

tambur

postojeće željezne spone uz tambur

www.spegra.hr

# POSTOJEĆE SPONE OD KORODIRANOG KOVANOG ŽELJEZA

GLAVNI ULAZ

LAĐA

stari klinovi za sidrenje spona

cfrp prsten-1.razina

TRANSEPT

ugaona kupola

ugaona kupola

central kupola

SVETIŠTE

ugaona kupola

ugaona kupola

TRANSEPT

www.spegra.hr

spegra

**CFRP POJAČANJE UGAONE KUPOLE-NIVO 2. CFRP PRSTENA**

www.spegra.hr

spegra

# SVETI VLAHO, STON

## OJAČAVANJE KONSTRUKCIJE SA FRP I FRG KOMPOZITIMA

www.spegra.hr

# IZRADA POSTELJICE OD REPARATURNOG MORTA NA KOJU SE UGRAĐUJE KARBONSKA TKANINA

spegra

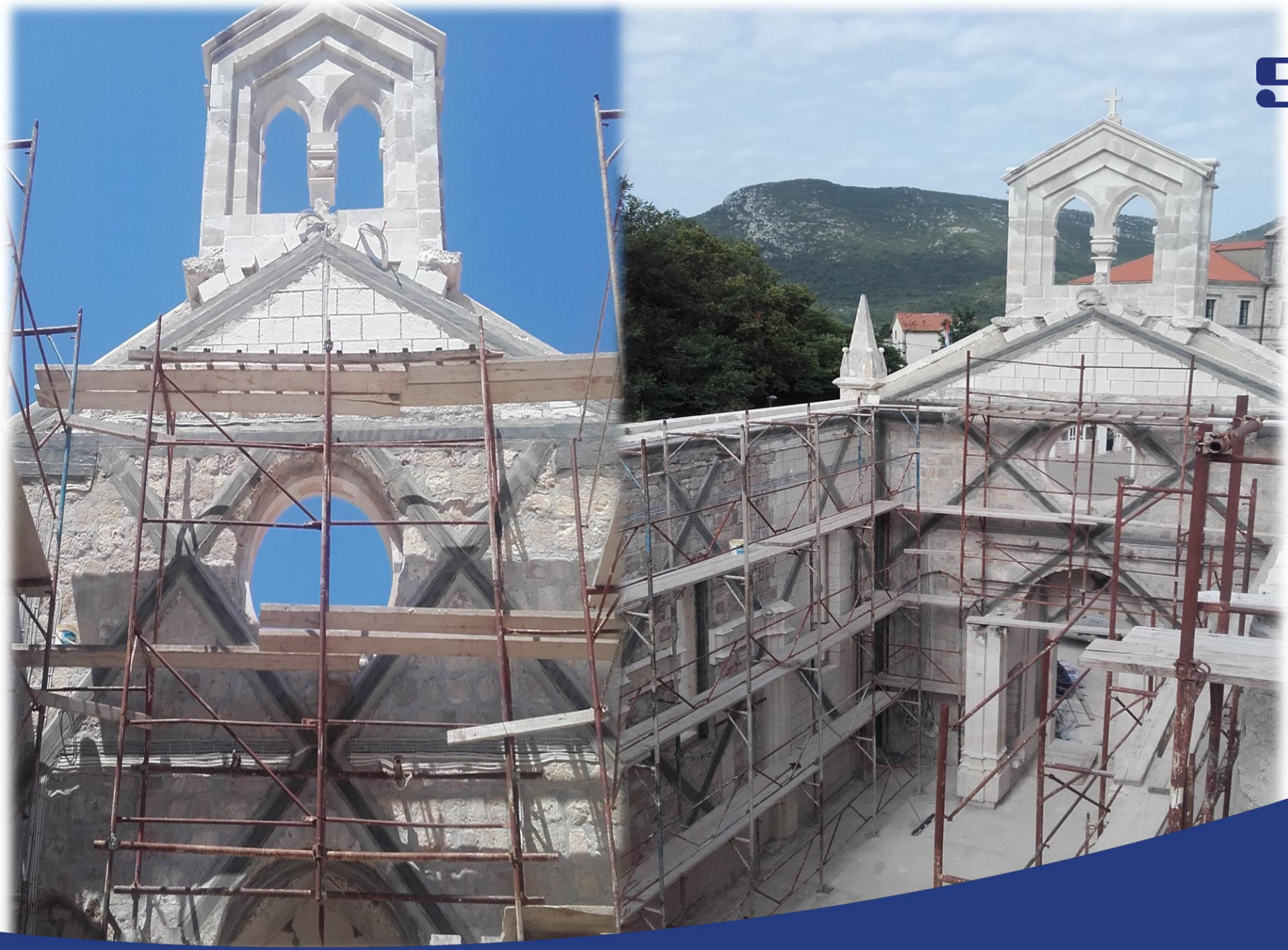
www.spegra.hr

**UGRADNJA KARBONSKIH TRAKA**

egra.hr

spegra

www.spegra.hr



spegra

www.spegra.hr

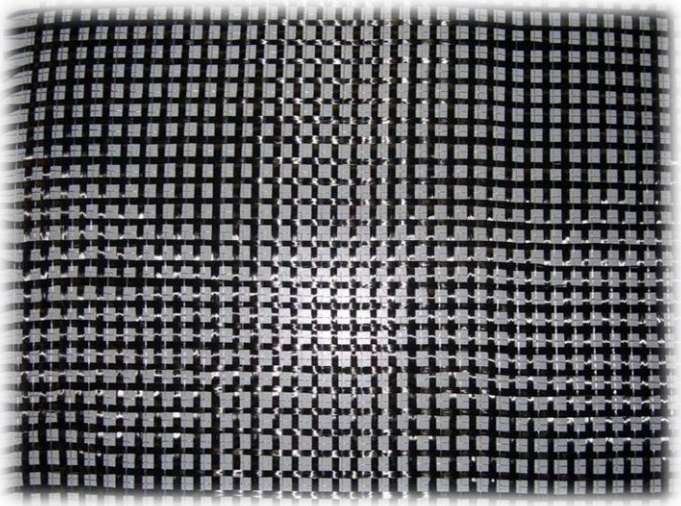
spegra

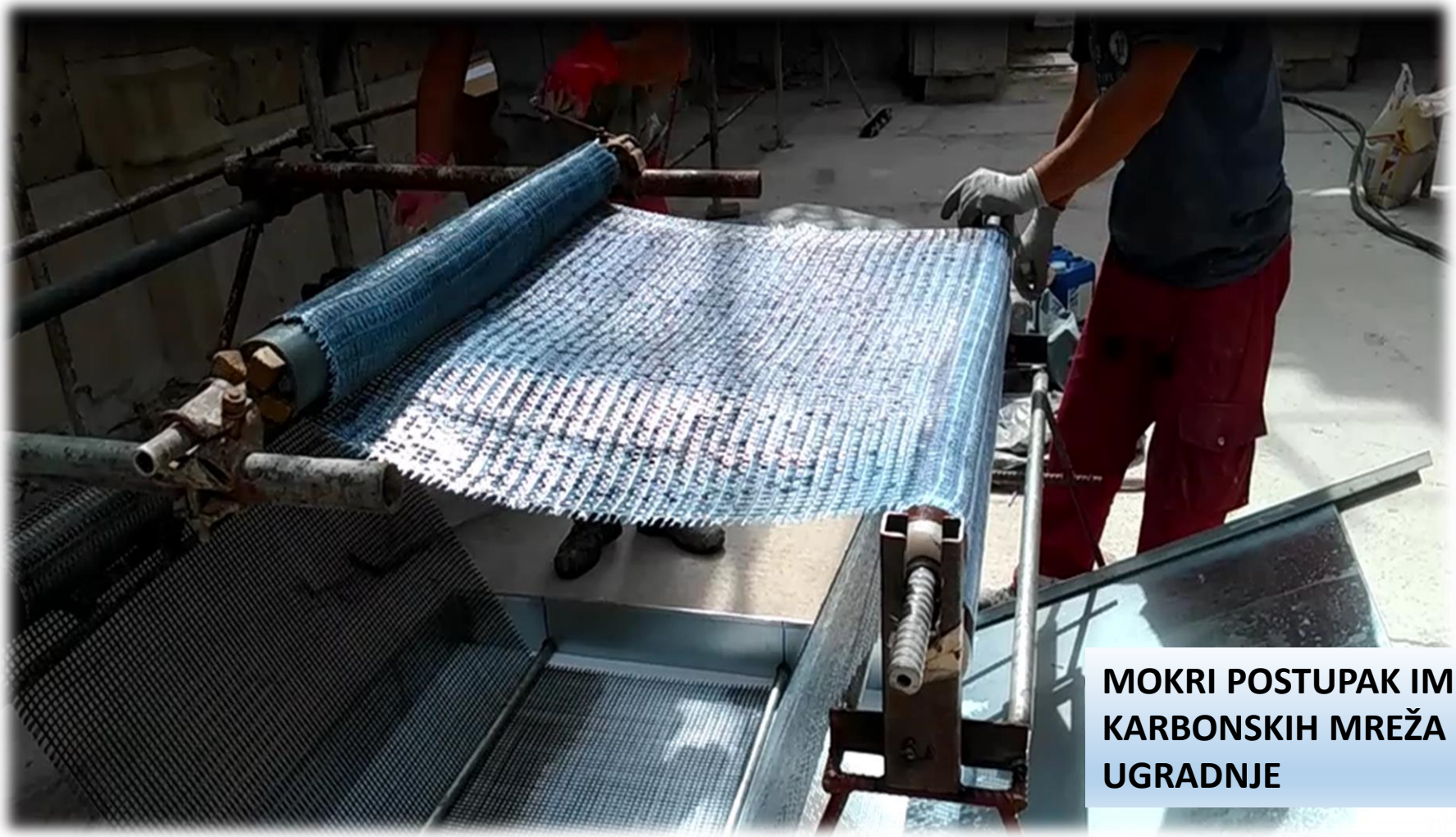
# PORAVNAVANJE ZIDOVA

www.spegra.hr

spegra

# IMPREGNIRANJE KARBONSKE MREŽE PRIJE UGRADNJE





**MOKRI POSTUPAK IMPREGNACIJE KARBONSKIH MREŽA PRIJE UGRADNJE**

# SVETI NIKOLA, KORČULA

## OJAČAVANJE ZVONIKA- KUPOLA SA PIRAMIDOM FRP KOMPOZITIMA

www.spegra.hr

spegra

www.spegra.hr


spegra

**POGLED NA KUPOLU NAKON SANACIJE**


spegra

www.spegra.hr

# KAMENE PLOČE NA KOJIMA JE IZGRAĐENA PIRAMIDA

spegra

**OJAČANJE PIRAMIDE KARBONSKIM TRAKA (ljepljenje Uni-ax 300/100 )**

www.spegra.hr

# OJAČANJE KAMENIHREBARA KARBONSKIM TRAKAMA (ljepljenje Uni-ax 300/100 )

# POSTAVLJANJE AKROTERIJA KROZ KOJEG SE UGRAĐUJE SIDRO

www.spegra.hr

spegra

# PALAČA U ULICI BRAĆE ANDRIJIĆA

# DUBROVNIK

## OJAČAVANJE SA FRP I FRG KOMPOZITIMA I SPREGNUTIM MEĐUKATNIM KONSTRUKCIJAMA

www.spegra.hr

spegra

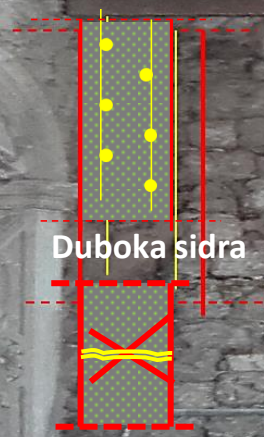
# STANJE OBJEKTA PRIJE POČETKA SANACIJE

spegra

## OTVORI I PUKOTINE U ZIDOVIMA

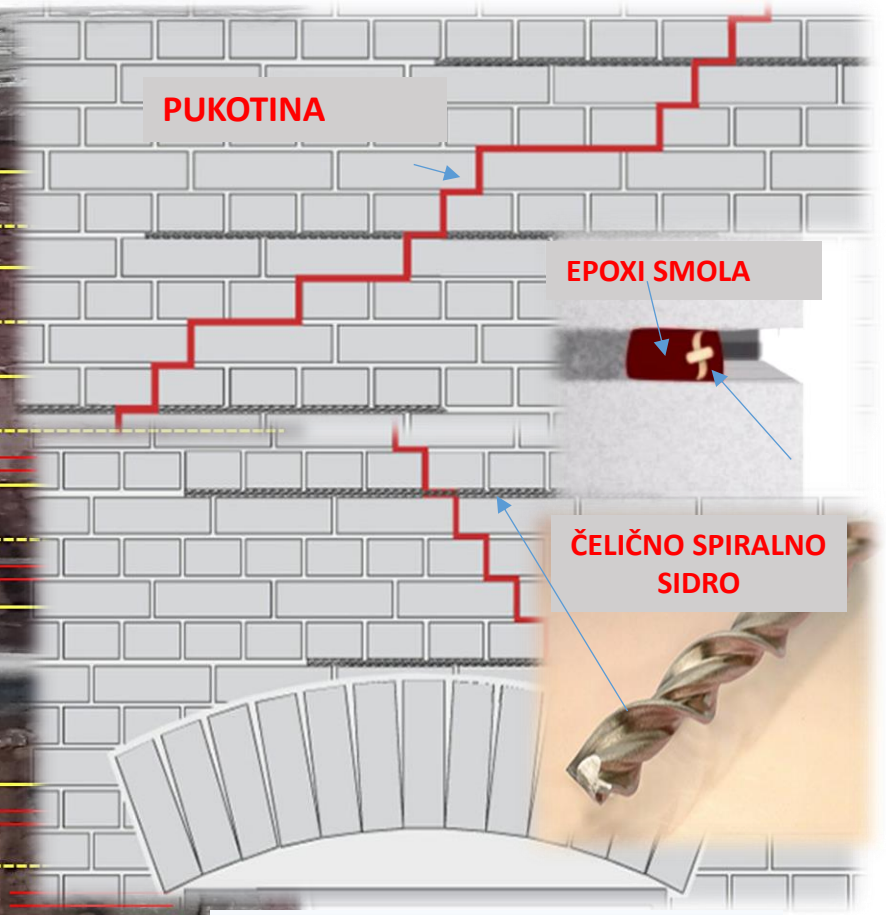
www.spegra.hr

# SIDRENJE KROZ PUKOTINSKU ZONU



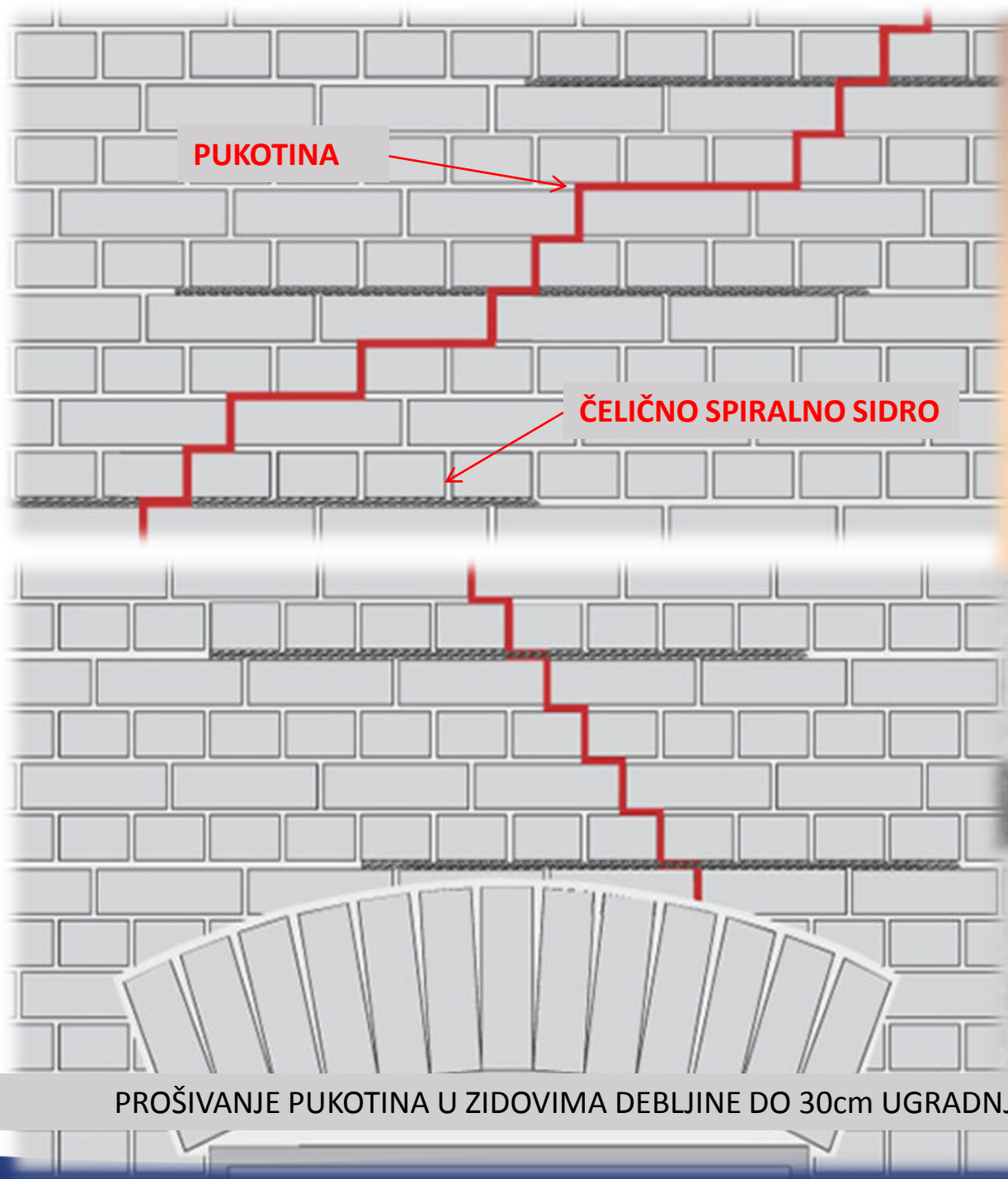

Ukrižana sidra

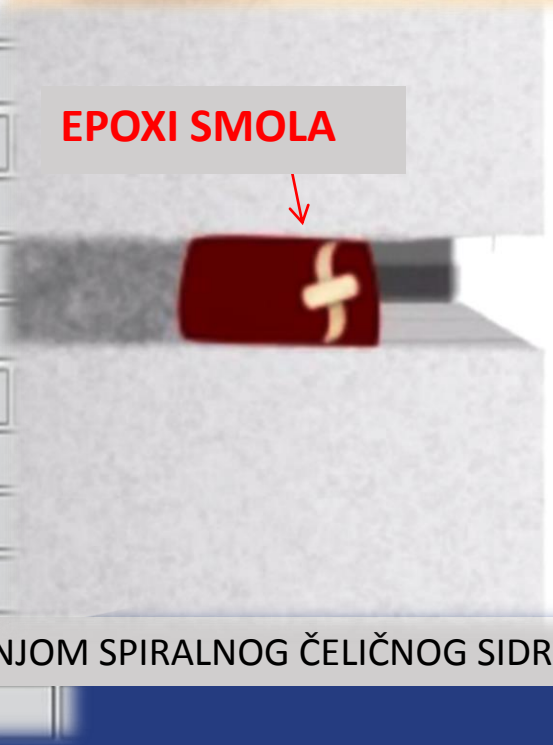
Duboka sidra




PROŠIVANJE PUKOTINA SA ČELIČNIM SPIRALNIM SIDROM

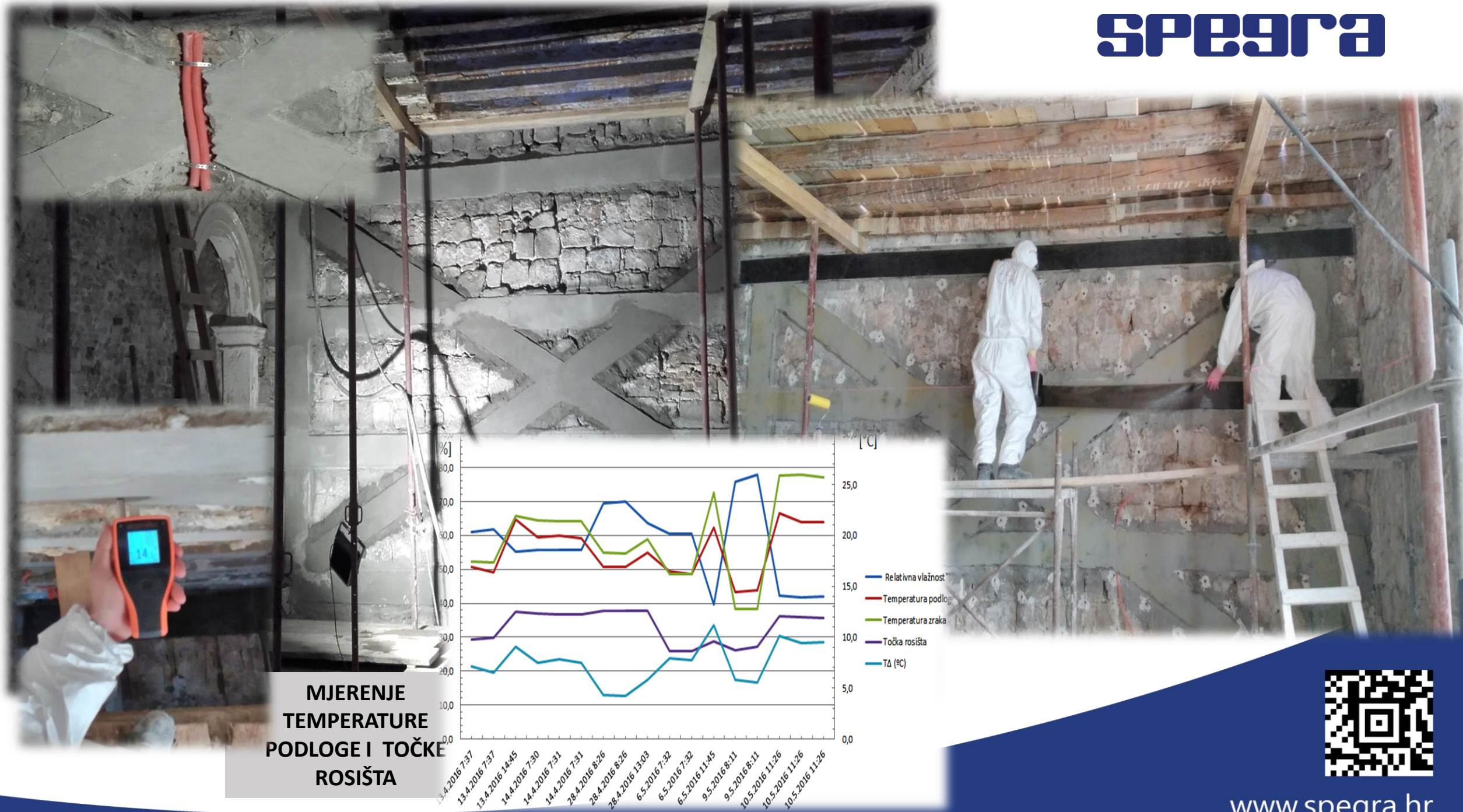
www.spegra.hr




PROŠIVANJE PUKOTINA U ZIDOVIMA DEBLJINE DO 30cm UGRADNJOM SPIRALNOG ČELIČNOG SIDRA

spegra




**MJERENJE TEMPERATURE PODLOGE I TOČKE ROSIŠTA**

www.spegra.hr

spegra

**UKLANJANJE OSLABLJENIH I RASPUCALIH DJELOVA KONSTRUKCIJE**

www.spegra.hr

**REPROFILIRANJE KAMENOG SVODA REPARATURNIM MORTOM I FRG OJAČANJE**

**SJECIŠTA KARBONSKIH TRAKA KOJE JE POTREBNO SIDRITI KARBONSKIM UŽETOM**

MJERENJE VLAŽNOSTI PODLOGE




SJECIŠTA KARBONSKIH TRAKA KOJE JE POTREBNO SIDRITI KARBONSKIM UŽETOM

KARBONSKE TRAKE PRIJE I POSLIJE SIDRENJA KARBONSKIM UŽETOM

**SJECIŠTA KARBONSKIH TRAKA KOJE JE POTREBNO SIDRITI KARBONSKIM UŽETOM**

www.spegra.hr


www.spegra.hr

spegra

www.spegra.hr

spegra

www.spegra.hr

spegra

www.spegra.hr

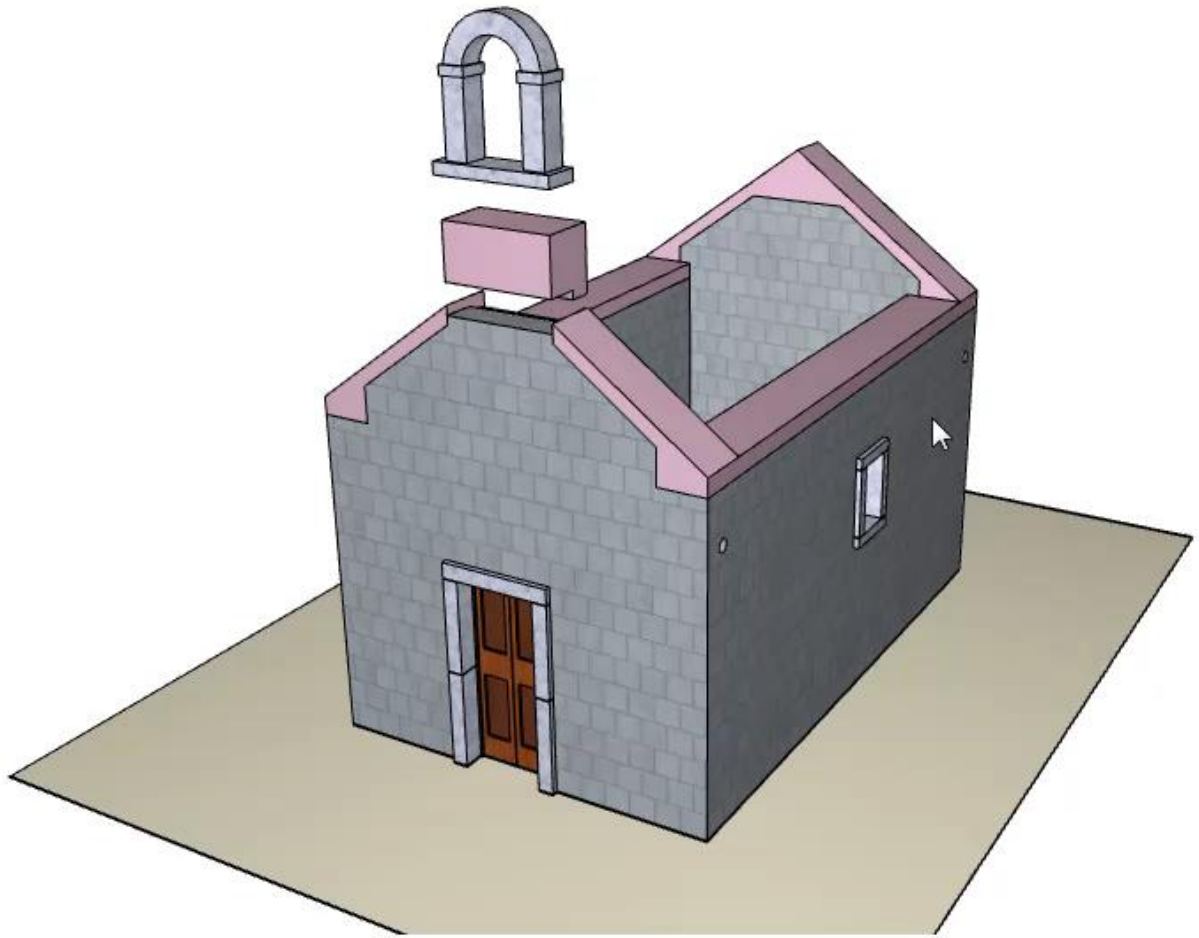
spegra

# SVETI IVAN
# LJUTA, KONAVLE

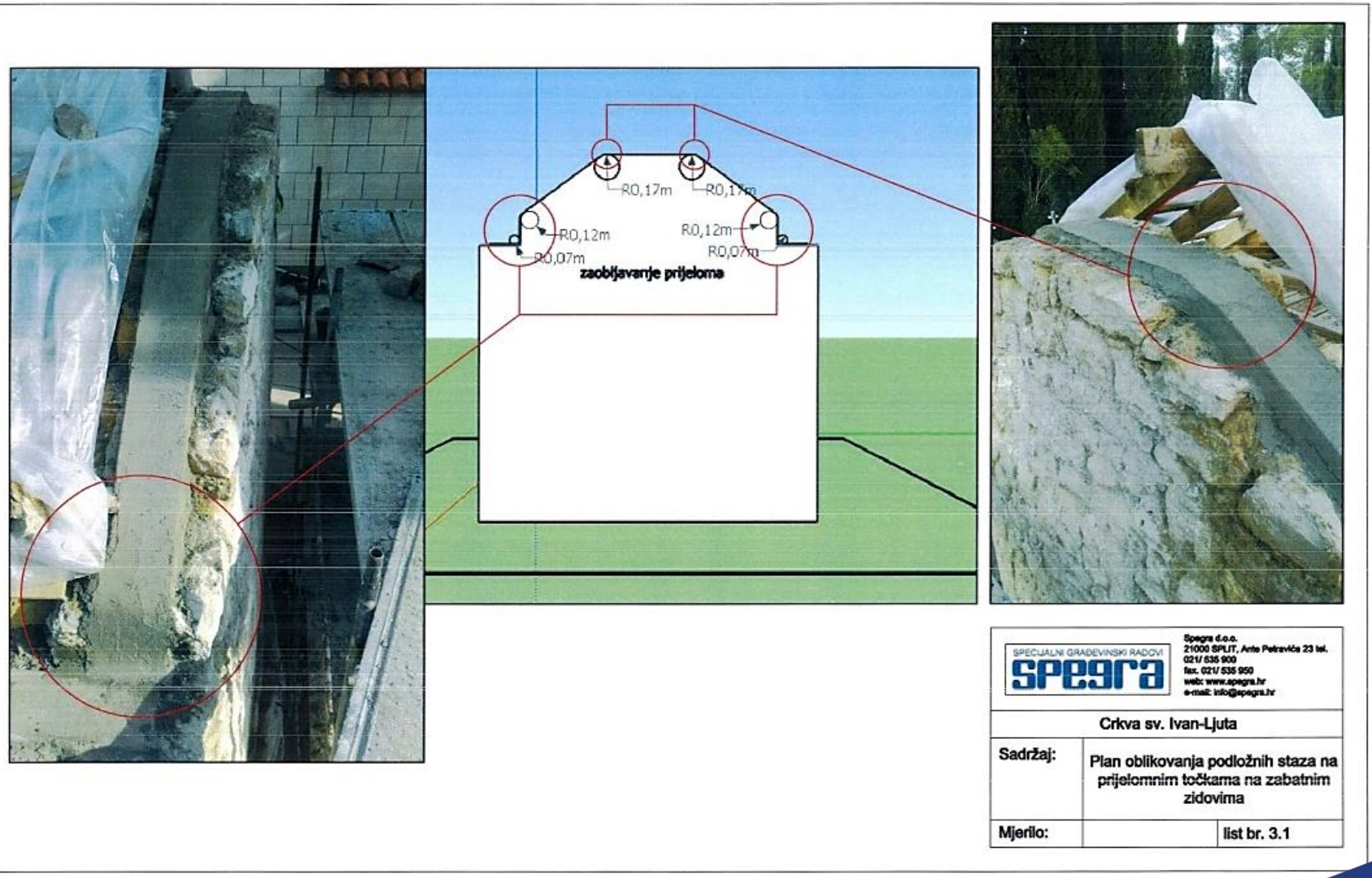
## IZRADA FRP SERKLAŽA

www.spegra.hr

spegra



www.spegra.hr


R0,17m
R0,17m
R0,12m
R0,07m
R0,12m
R0,07m
zaobljavanje prijeloma
SPECIJALNI GRAĐEVINSKI RADOVI
spegra
Spegra d.o.o.
21000 SPLIT, Ante Petravića 23 tel.
021/ 535 900
fax. 021/ 535 950
web: www.spegra.hr
e-mail: info@spegra.hr
Crkva sv. Ivan-Ljuta
Sadržaj:
Plan oblikovanja podložnih staza na prijelomnim točkama na zabatnim zidovima
Mjerilo:
list br. 3.1

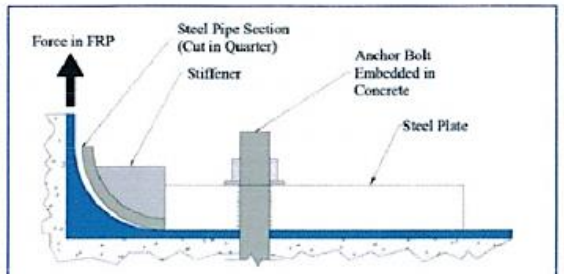



Fig. 13
Anchorage system studied in Grelle (2011).

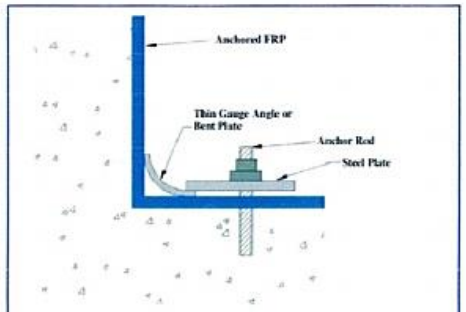
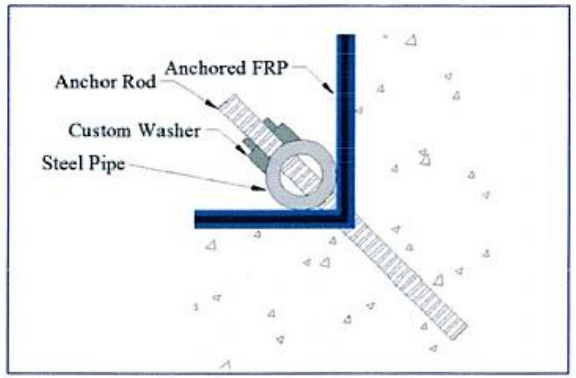



Fig. 12
Ductile anchorage system (adapted from Hall et al. 2002).



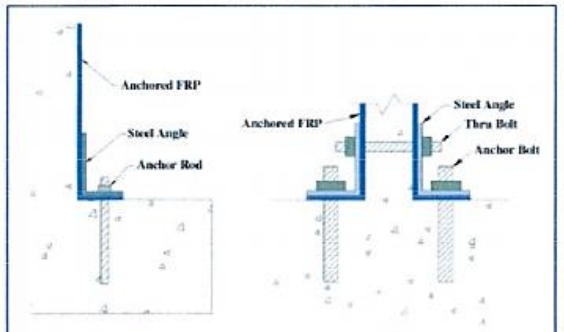
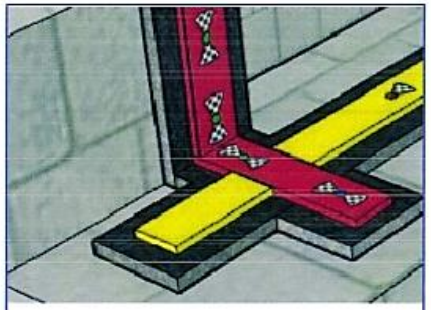
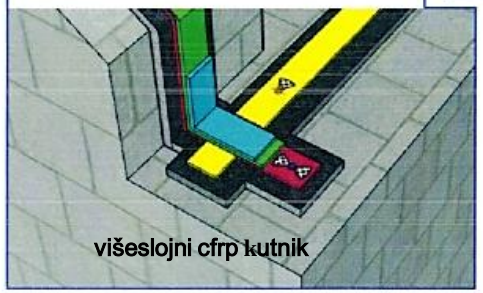




Fig. 10
Bolted angle systems.





višeslojni cfrp kutnik

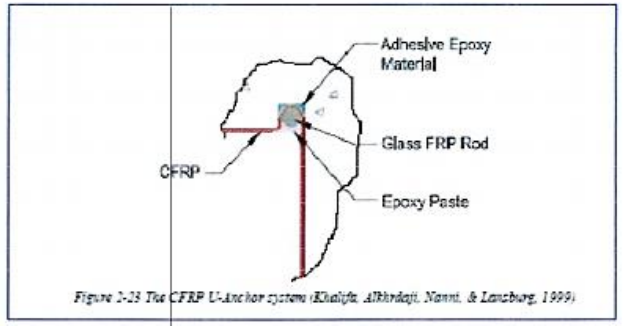



Figure 2-23 The CFRP U-Anchor system (Khalifa, Alkhrdaji, Nanni, & Lansburg, 1999)

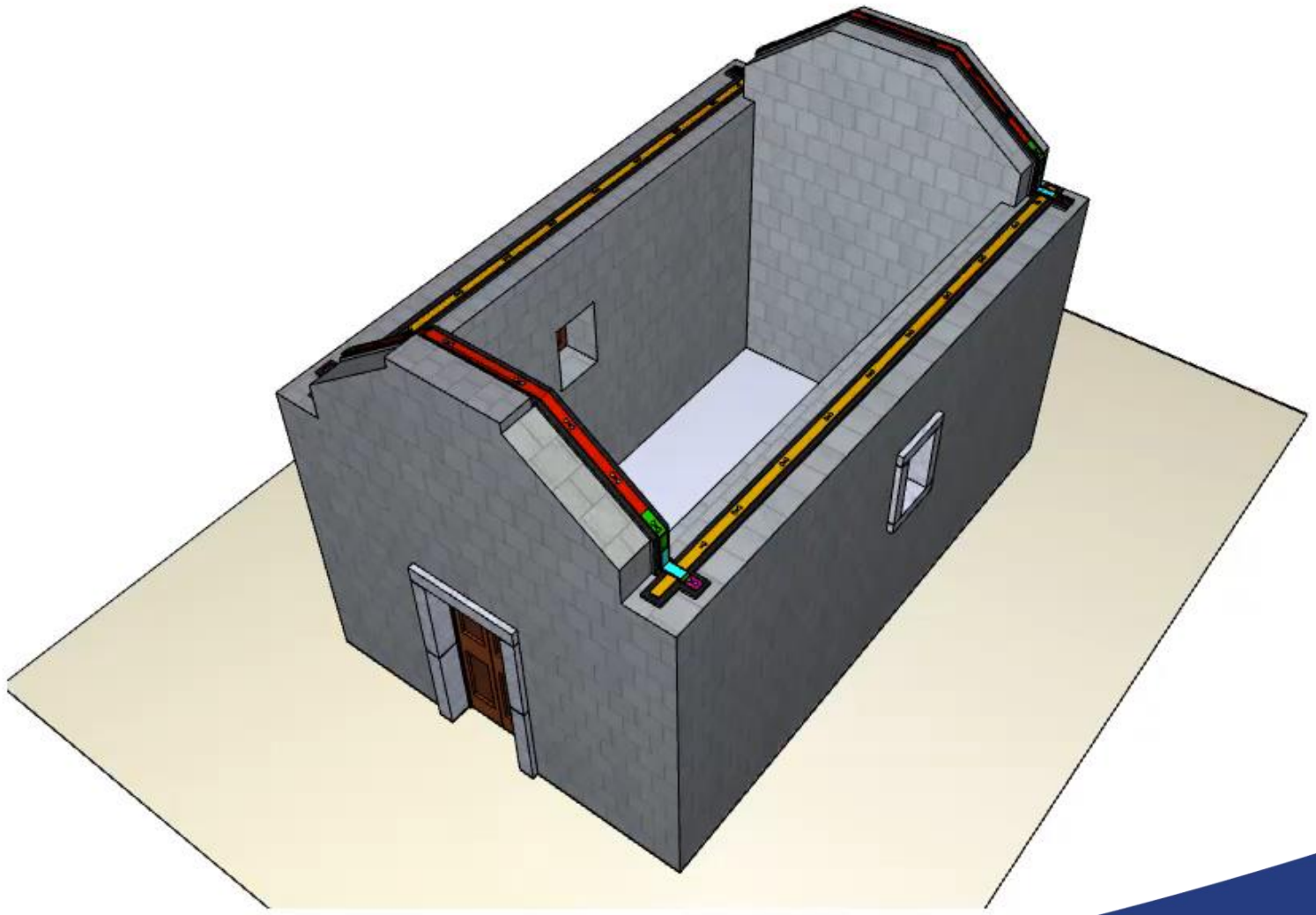
USVOJENI MODEL-TIP SPEGRA

SPECIJALNI GRAĐEVINSKI RADOVI spegra

Spegra d.o.o.
21000 SPLIT, Ante Petravića 23 tel.
021/ 535 900
fax. 021/ 535 950
web: www.spegra.hr
e-mail: info@spegra.hr

| | | |
|---|---|---|
| Crkva sv. Ivan-Ljuta | | |
| Sadržaj: | Modiel sidrenja CFRP pojačanja na konkavnom prijelomu | |
| Mjerilo: | | list br. 6.1 |

spegra



www.spegra.hr

spegra

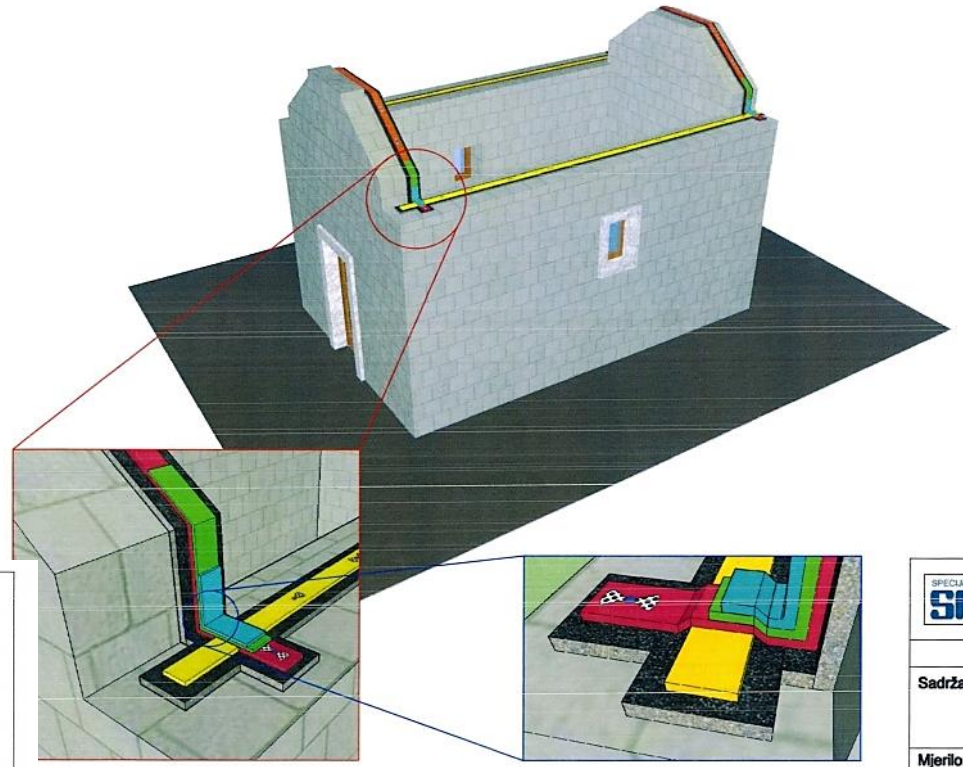
SPECIJALNI GRADEVINSKI RADOVI spegra
Spegra d.o.o.
21000 SPLIT, Ante Petravića 23 tel.
021/ 535 900
fax. 021/ 535 950
web: www.spegra.hr
e-mail: info@spegra.hr

Crkva sv. Ivan-Ljuta

Redoslijed ugradnje karbonskih trak

LEGENDA

1. korak
2. korak
3. korak
4. korak







SPECIJALNI GRADEVINSKI RADOVI spegra
Spegra d.o.o.
21000 SPLIT, Ante Petravića 23 tel.
021/ 535 900
fax. 021/ 535 950
web: www.spegra.hr
e-mail: info@spegra.hr

Crkva sv. Ivan-Ljuta

| | |
|---|---|
| Sadržaj: | Četvrta faza radova "Polaganje karbonskih traka u 3. i 4. koraku-detaljni prikaz spoja na prijelazu s uzdužnog na zabatni zid" |
| Mjerilo: | list br. 6 |

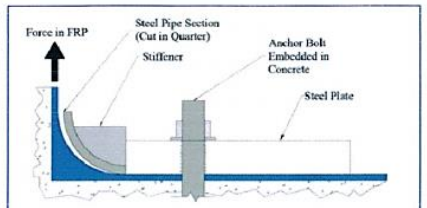



Fig. 13
Anchorage system studied in Grelle (2011).

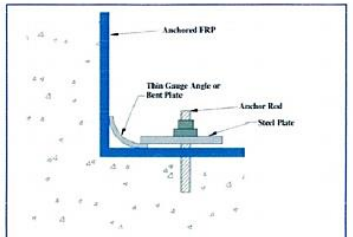
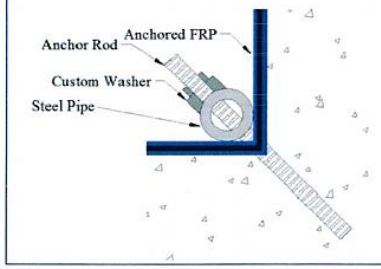



Fig. 12
Ductile anchorage system (adapted from Hall et al. 2002).



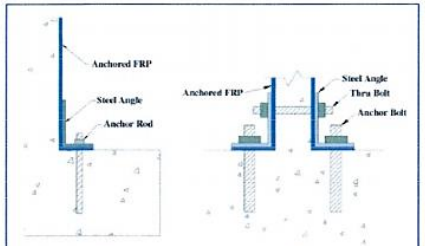
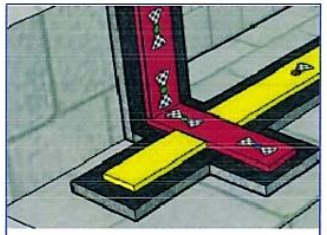




Fig. 10
Bolted angle systems.



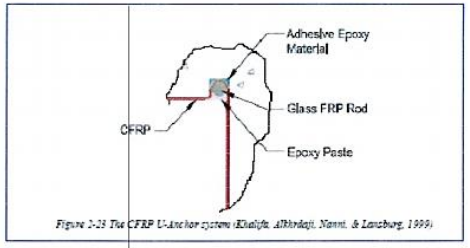
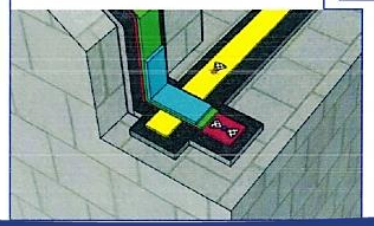



Figure 2-28 The CFRP U-Anchor system (Khalifa, Alkhrdaji, Nanni, & Lanzburg, 1999)



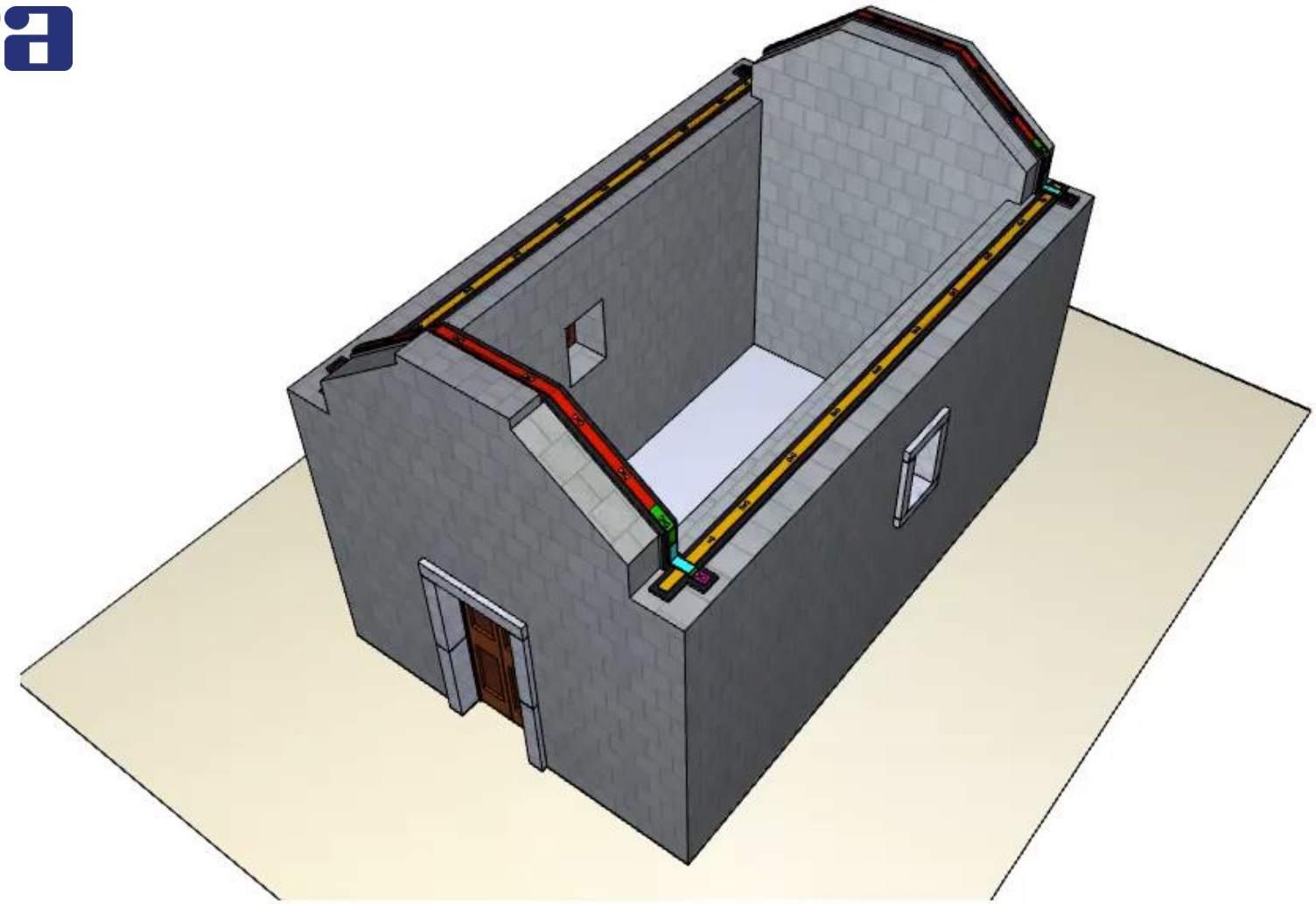
SPECIJALNI GRADEVINSKI RADOVI spegra
Spegra d.o.o.
21000 SPLIT, Ante Petravića 23 tel.
021/ 535 900
fax. 021/ 535 950
web: www.spegra.hr
e-mail: info@spegra.hr

Crkva sv. Ivan-Ljuta

| | |
|---|---|
| Sadržaj: | Modiel sidrenja CFRP pojačanja na konkavnom prijelomu |
| Mjerilo: | |

www.spegra.hr

spegra



www.spegra.hr

www.spegra.hr

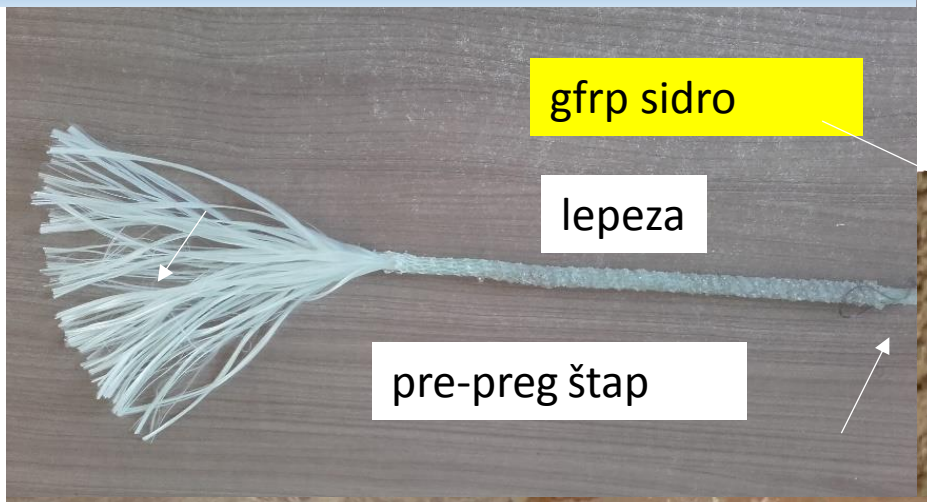

spegra

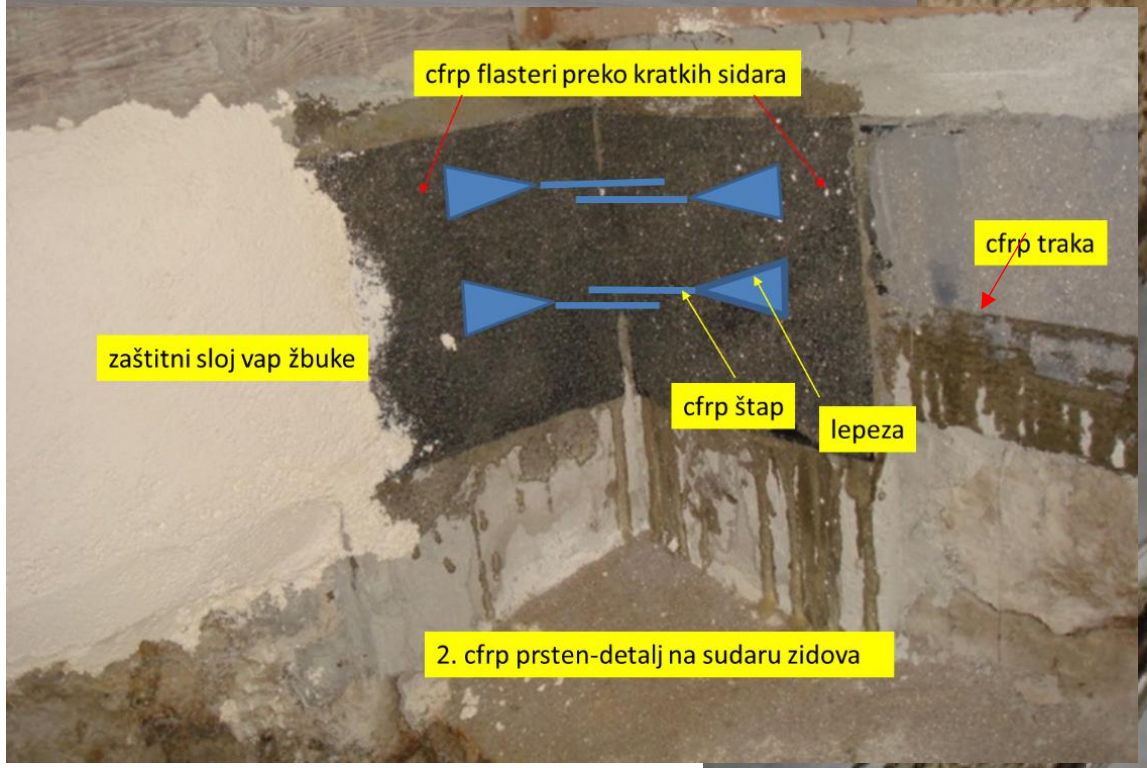
# C(G)FRP SIDRA

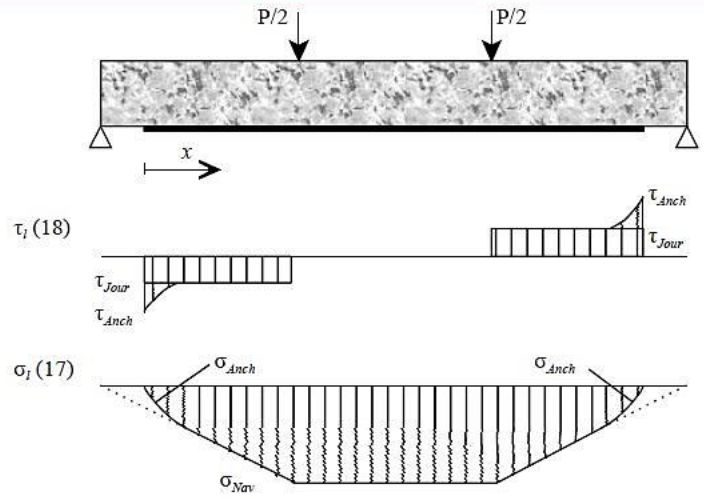
## KRATKE INSTRUKCIJE OPĆENITO

www.spegra.hr

# Predgotovljena (pre-preg) karbonska sidra




**Figuur 13** Schuifspanningen en trekspanningen aan het plaatuiteinde

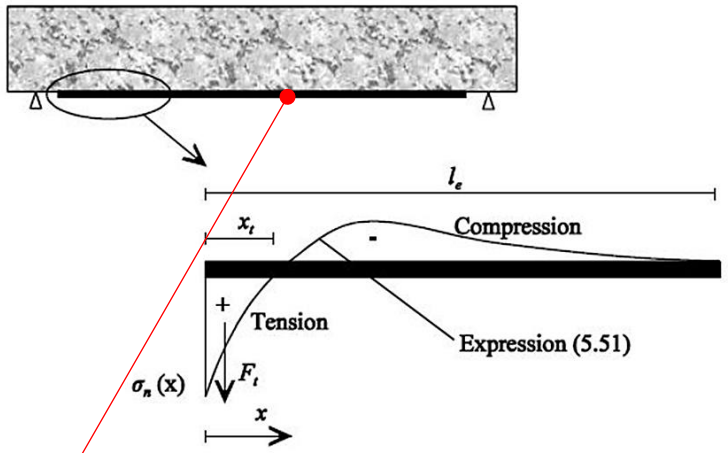



**Figure 5.6** Normal stress distribution at the end of the laminate

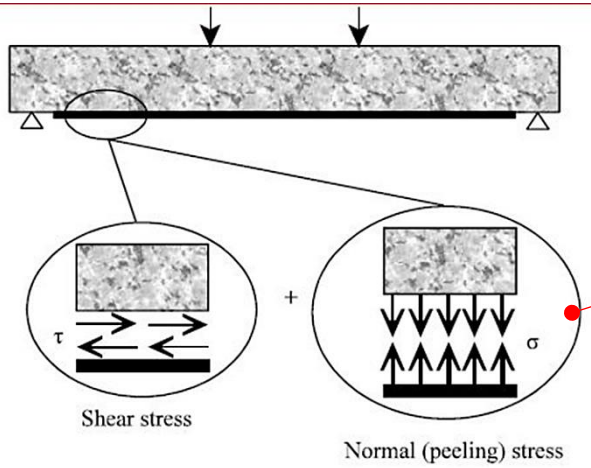



**Figure 1.12** Shear and normal stresses for a combined bending/shear case

## NAPONSKO STANJE NA KRAJEVIMA CFRP LINJSKOG POJAČANJA

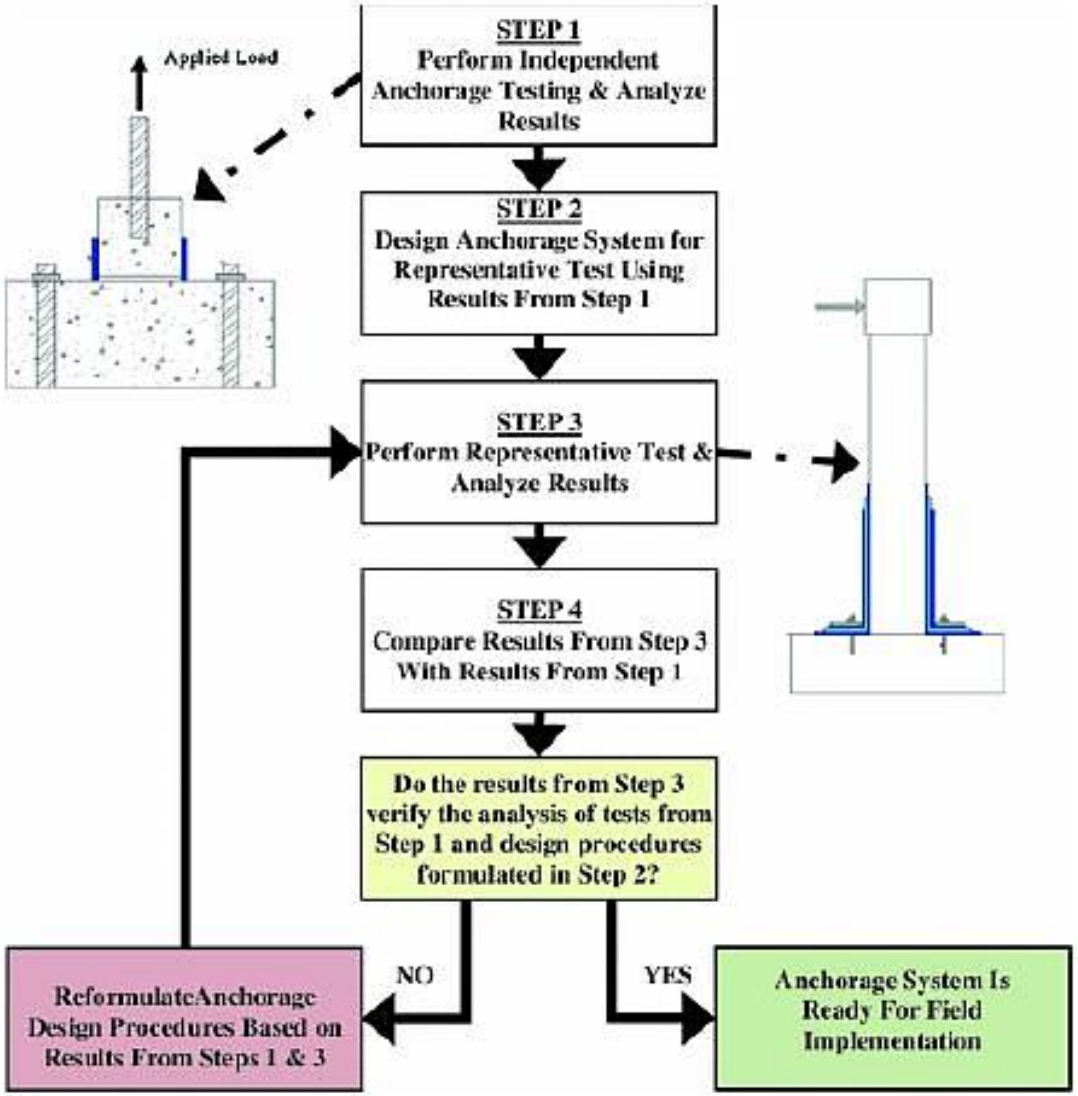



Fig. 14

Process leading to field implementation of new anchorage systems.

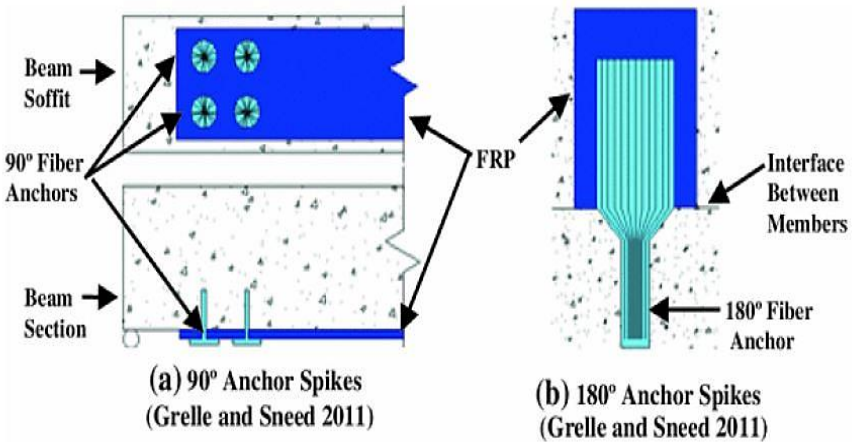



Fig. 4

Comparison of 90° and 180° anchor spikes.

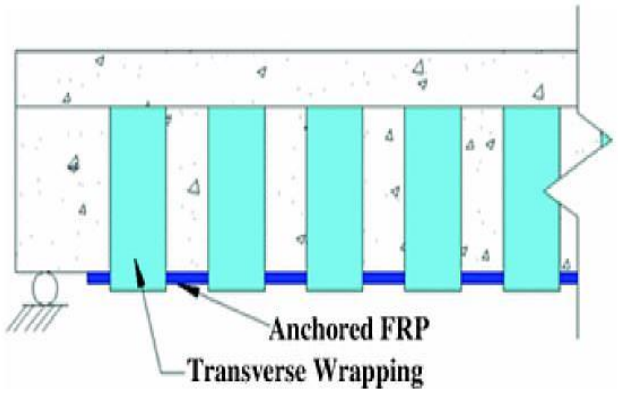



Fig. 5

Example of transverse wrapping anchorage on T-beam.

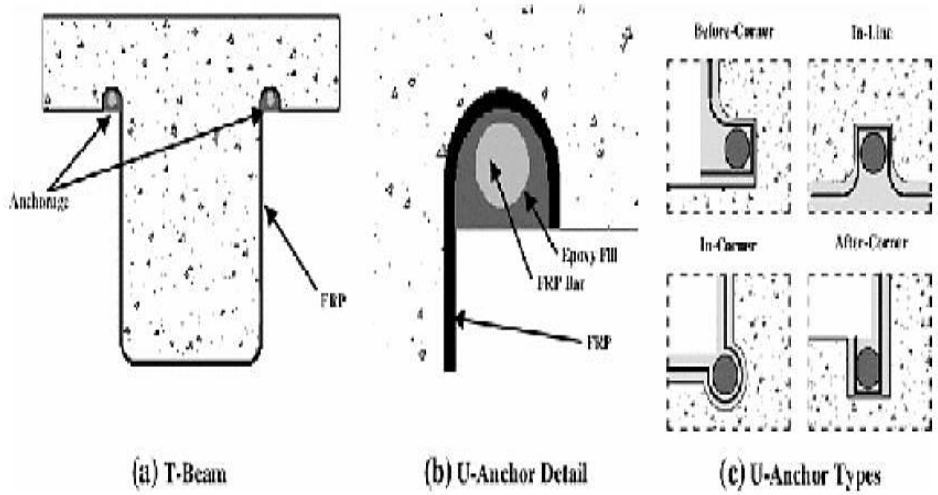



Fig. 6

Schematic of typical U-Anchor (Grelle and Sneed 2011).

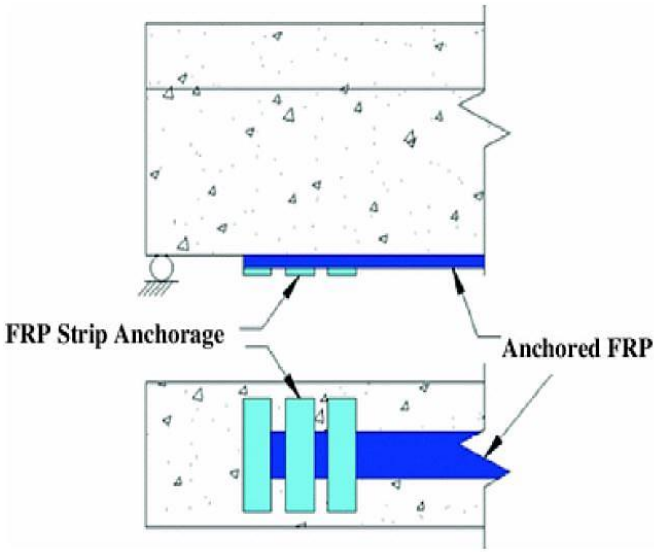
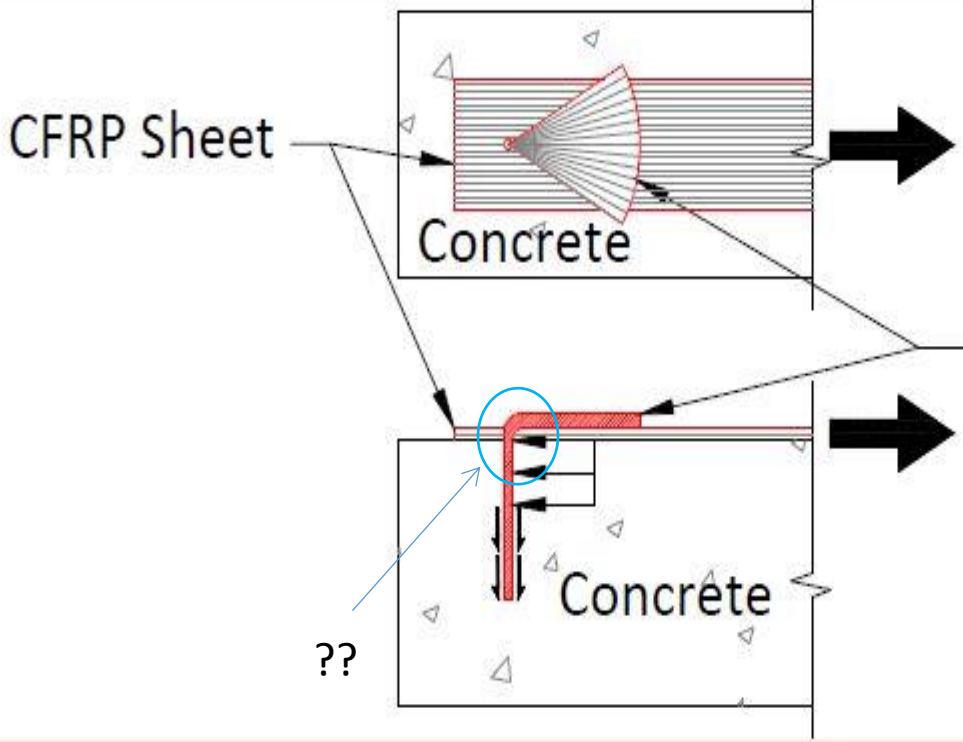
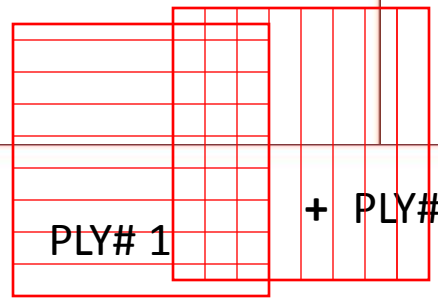



Fig. 8

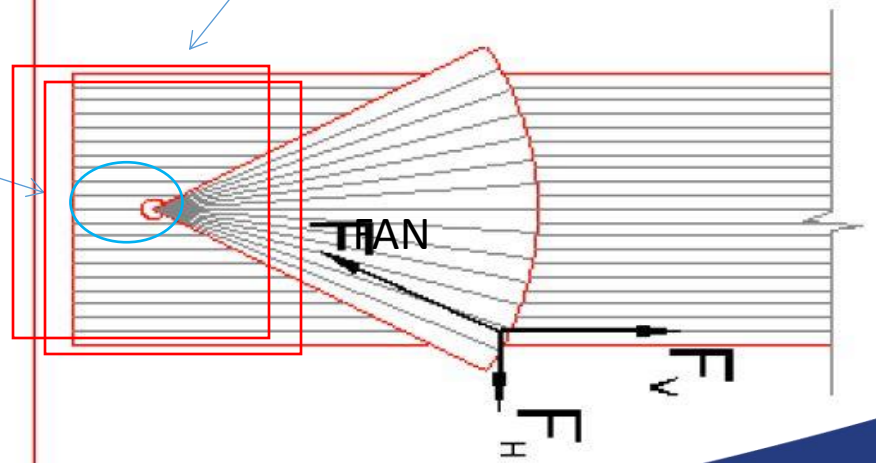
FRP strip anchorage.



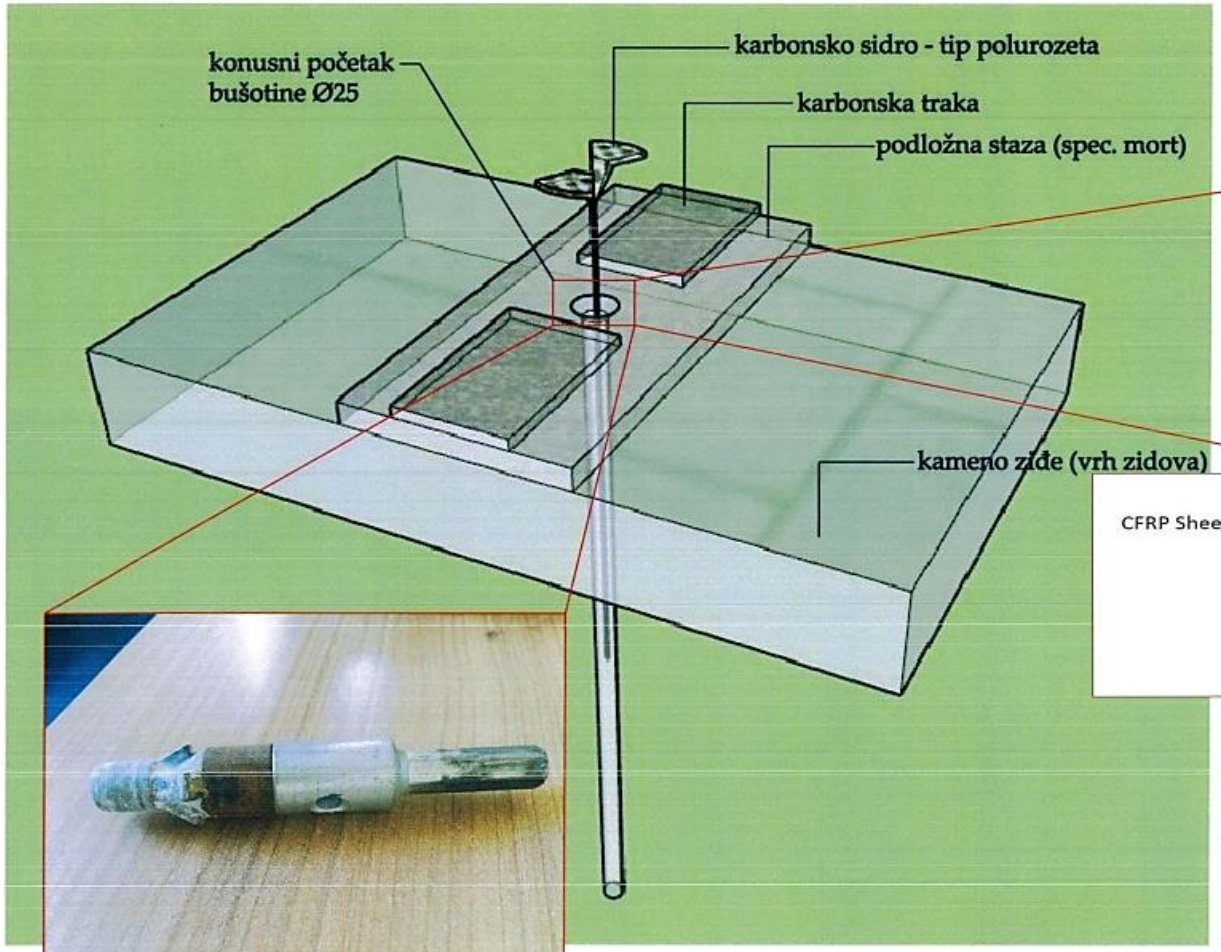

the anchor fractured at the opening in the CFRP anchor hole, but only after the CFRP strips reached tensile strains in excess of the manufacturer's reported fracture strain.

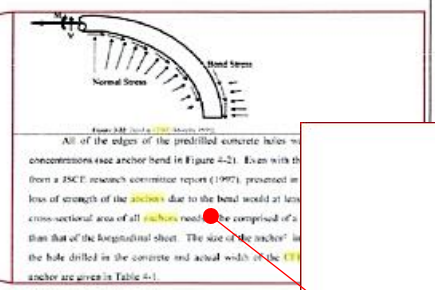



??

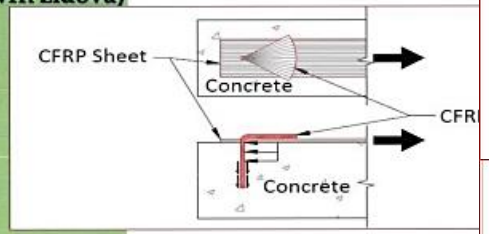



www.spegra.hr




All of the edges of the predrilled concrete holes w
concentrations (see anchor bend in Figure 4-2). Even with th
from a JSCE research committee report (1997), presented in
loss of strength of the anchors due to the bend would at leas
cross-sectional area of all anchors needs to be comprised of a
than that of the longitudinal sheet. The size of the anchor² in
the hole drilled in the concrete and actual width of the CFR
anchor are given in Table 4-1.




| | | |
|---|---|---|
| SPECIJALNI GRAĐEVINSKI RADOVI spegra | Spegra d.o.o. 21000 SPLIT, Ante 021/ 535 900 fax. 021/ 535 950 web: www.spegra.h e-mail: info@spegra | |
| Crkva sv. Ivan-Ljuta | | |
| Sadržaj: | Karbonsko kratko sidro-polurozeta | |
| Mjerilo: | | list br |

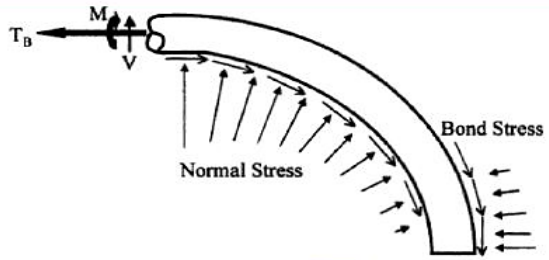
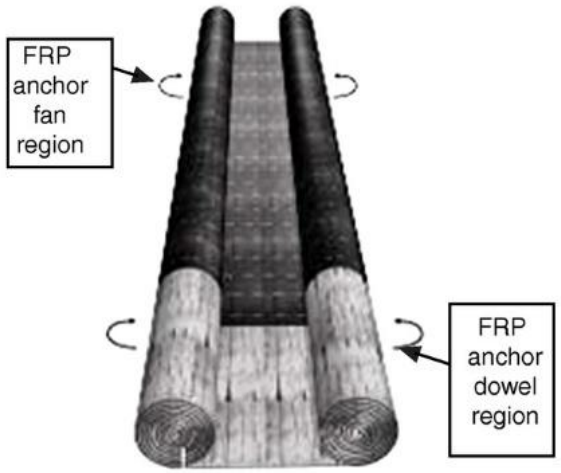



**Figure 3-22** Bend in CFRP [Morphy 1999]

The stress transfer mechanism of the carbon fiber sheets has been studied by

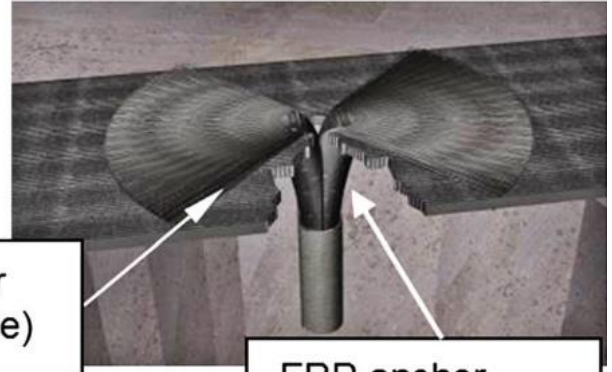
All of the edges of the predrilled concrete holes were rounded to limit stress concentrations (see anchor bend in Figure 4-2). Even with the rounded edges, equations from a JSCE research committee report (1997), presented in Chapter 3, predict that the loss of strength of the anchors due to the bend would at least 50%. Therefore, the total cross-sectional area of all anchors needs to be comprised of a cross-sectional area greater than that of the longitudinal sheet. The size of the anchor[2] in relation to the diameter of the hole drilled in the concrete and actual width of the CFRP sheet used to make the anchor are given in Table 4-1.


FRP anchor fan region
FRP anchor dowel region

(a)

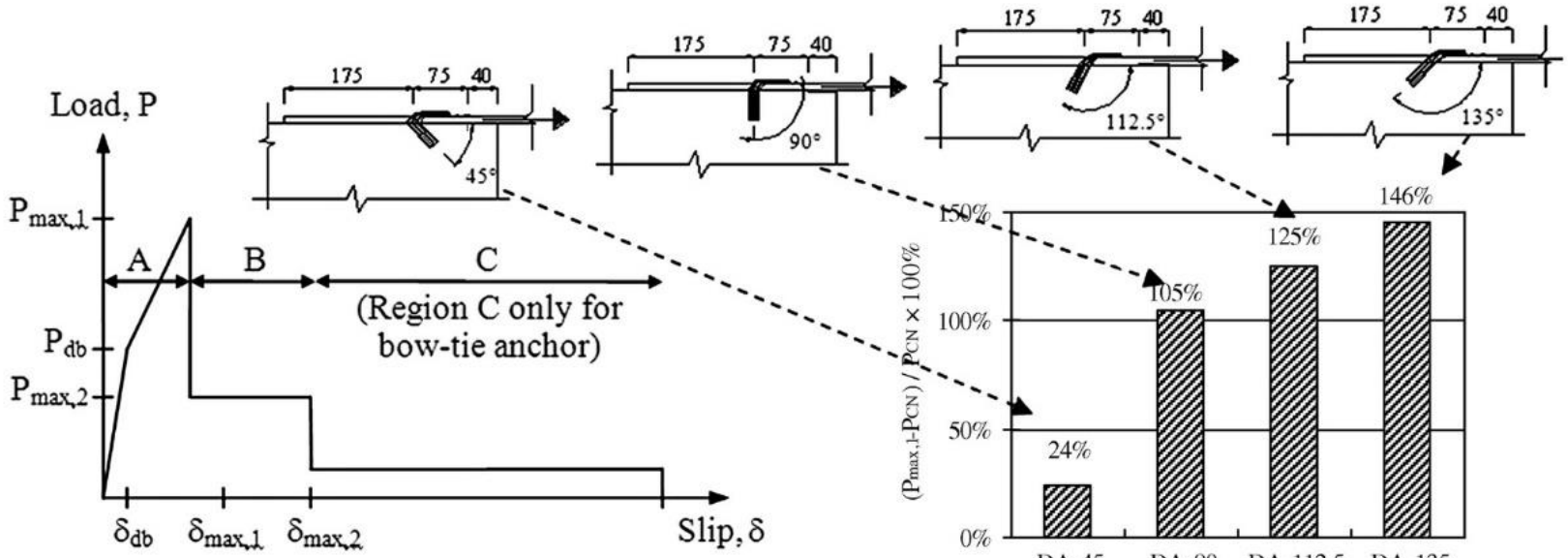

Anchor Fans

(b)


FRP anchor fans (bow-tie)
FRP anchor dowel

(c)

(d)


Load, P
$P_{max,1}$
$P_{db}$
$P_{max,2}$
A
B
C
(Region C only for bow-tie anchor)
$\delta_{db}$
$\delta_{max,1}$
$\delta_{max,2}$
Slip, δ
175 75 40
45°
90°
112.5°
135°
$(P_{max,1}-P_{CN}) / P_{CN} \times 100\%$
150%
100%
50%
0%
24%
105%
125%
146%
DA-45
DA-90
DA-112.5
DA-135

(e)

(f)



# OPIT ČUPANJA FRP SIDRA

# GOSPA OD MILOSRĐA, DUBROVNIK

## SNACIJA ROZETE SA FRP KOMPOZITOM

www.spegra.hr

spegra

CENTRALNI DIO ROZETE S ZNAČAJNIM OŠTEĆENJIMA

PRIPREMA ZA RAZGRADNJU ROZETE U RADIONICI

www.spegra.hr

RASTAVLJENI DIJELOVI ROZETE

www.spegra.hr

**OBJE POLOVICE ROZETE POJAČANE CFRP SUSTAVOM (unutarnja strana rozete)**

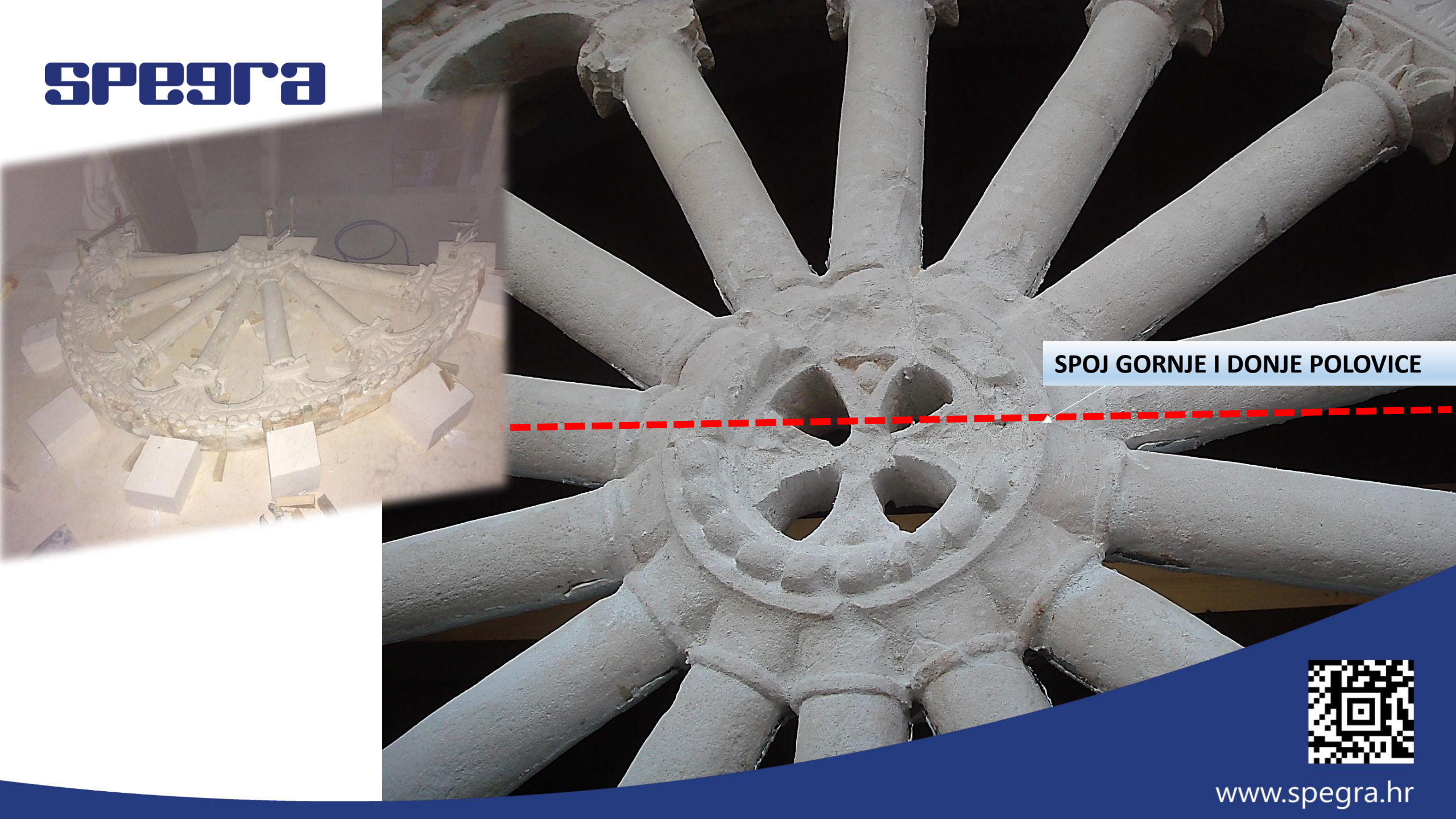
www.spegra.hr

spegra

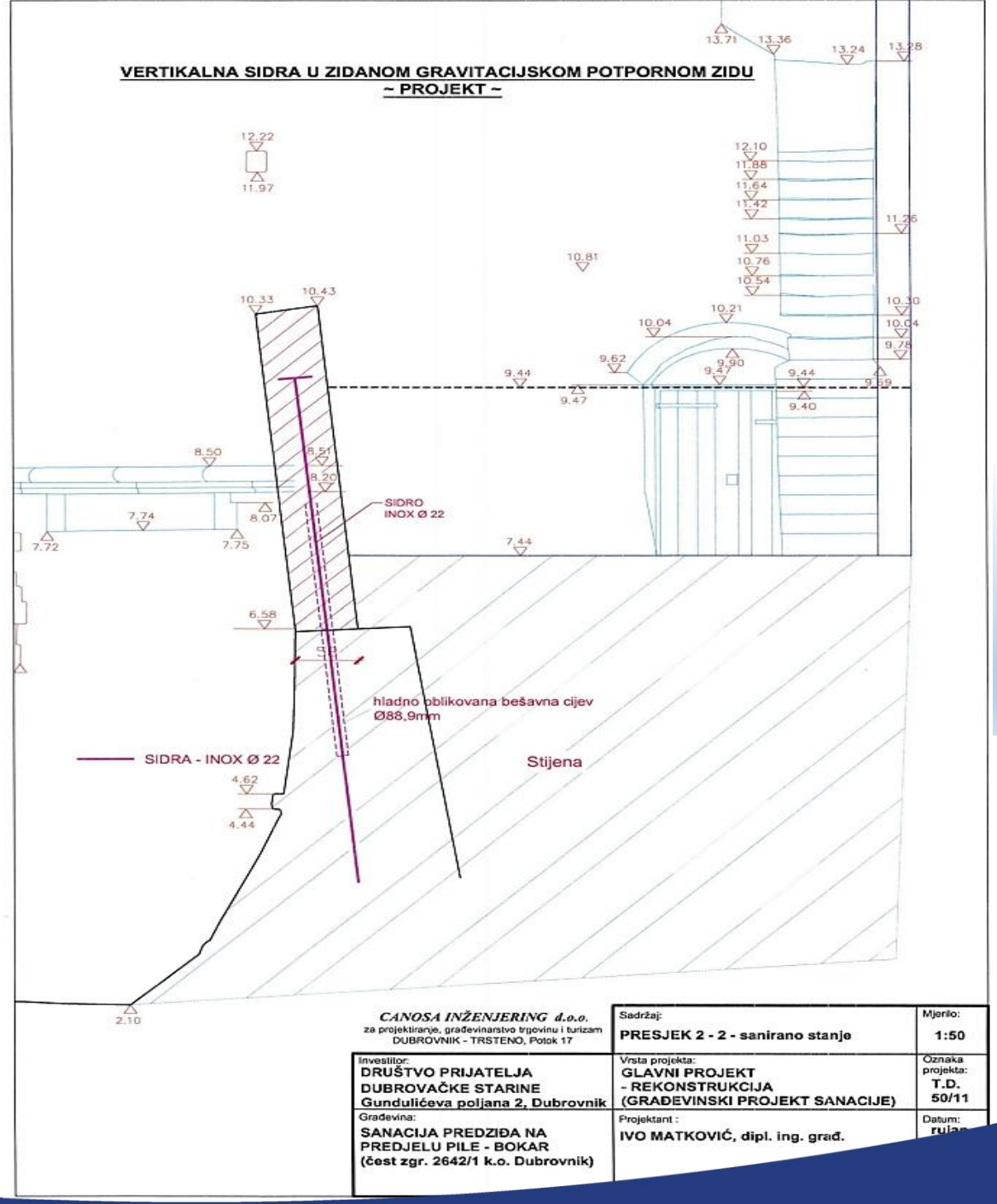
**UGRAĐENA POJAČANA ROZETA**

**POGLED IZNUTRA**

spegra




www.spegra.hr

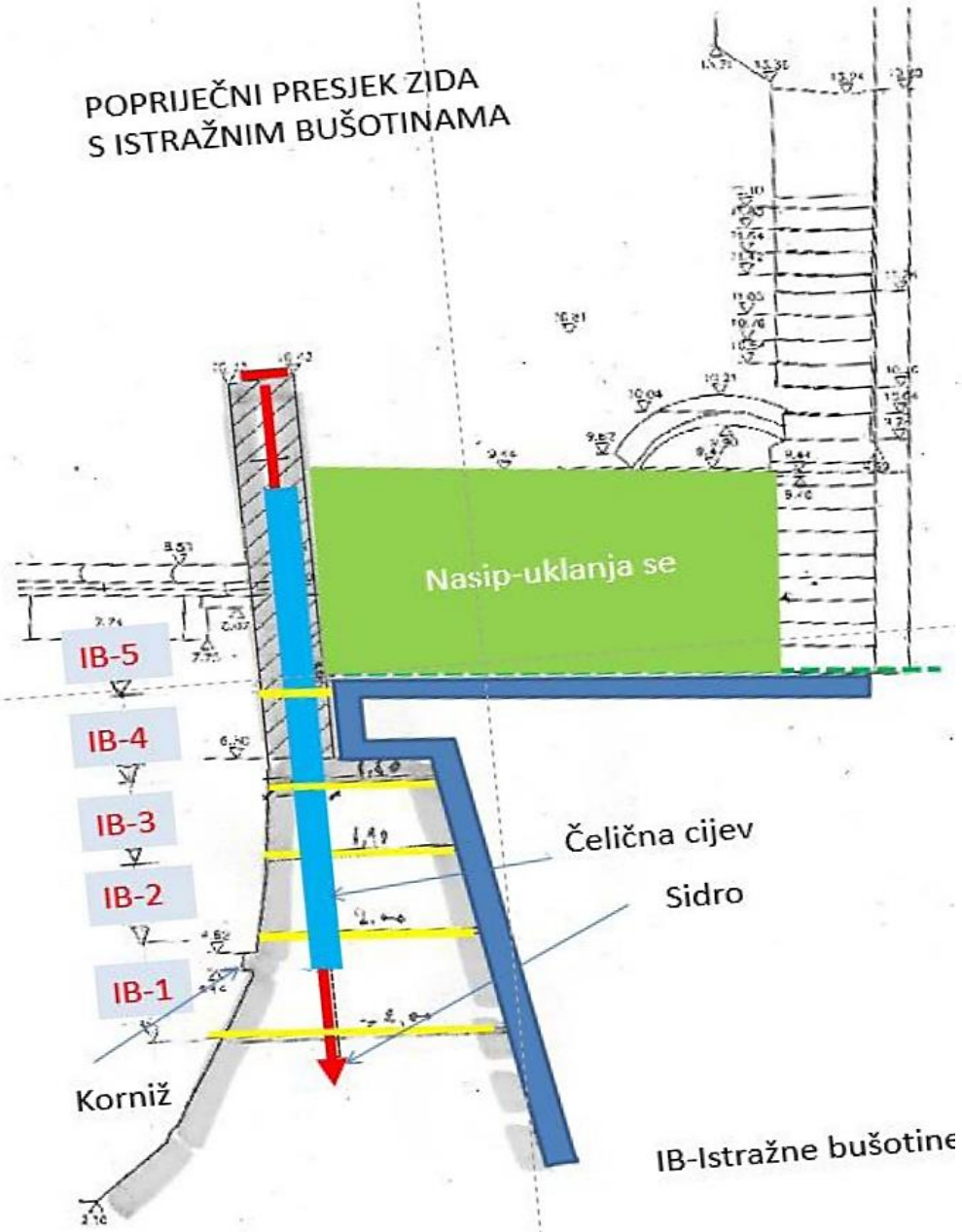


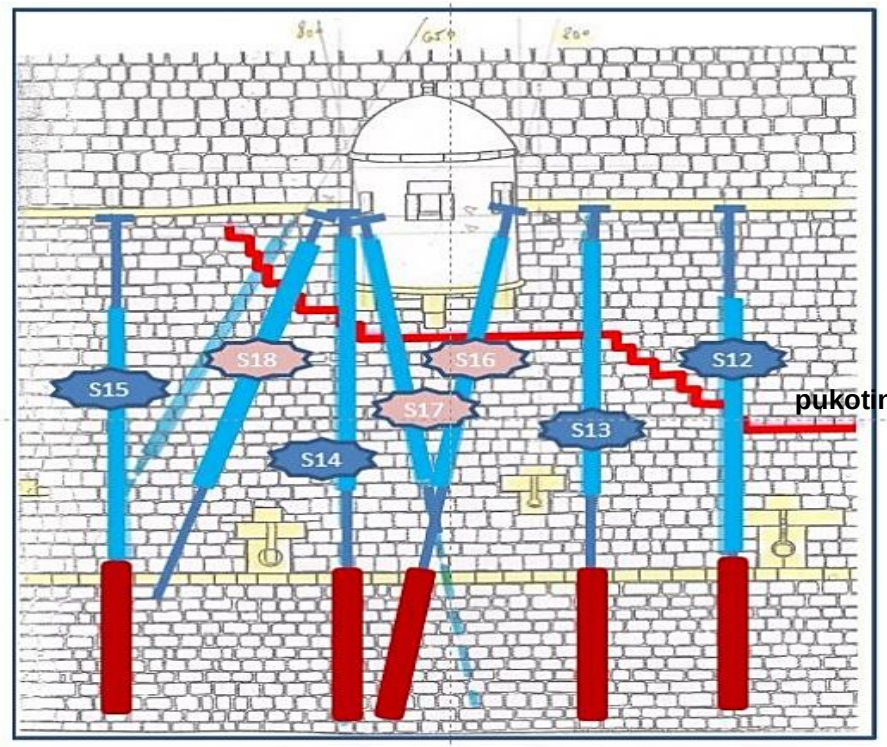

# PREDZIĐE PILE BOKAR POVJESNA JEZGRA,DUBROVNIK

## OJAČAVANJE ZIDA SIDRENJEM

www.spegra.hr

POPRIJEČNI PRESJEK ZIDA
S ISTRAŽNIM BUŠOTINAMA




pukotina u zidu

NAPOMENA:
**Sidra: S16,S17,S18 dodatno su ubačena za ojačanje stražarnice**

PREDZIĐE PILE-BOKAR: OJAČANJE STRAŽARNICE

www.spegra.hr

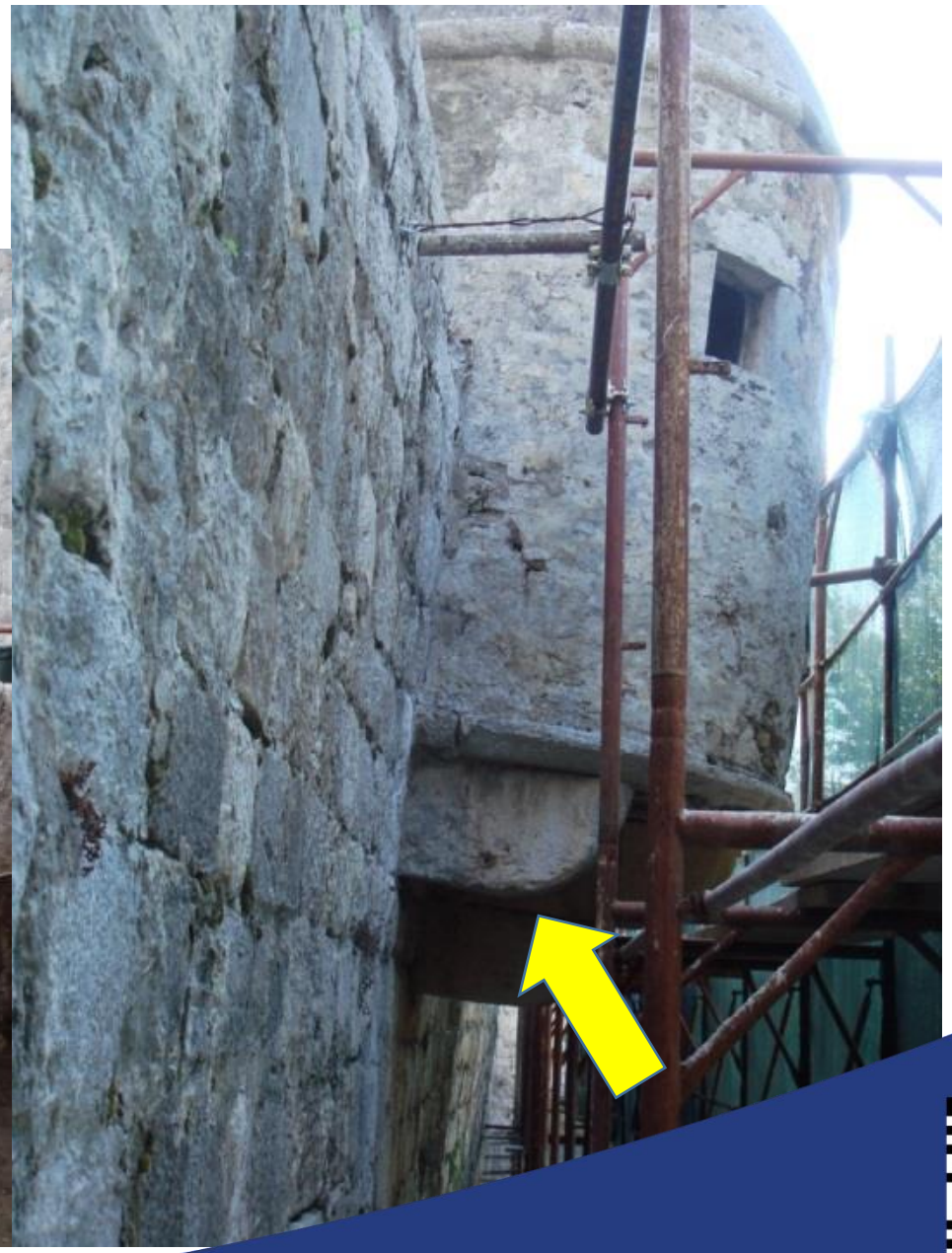
## PREŠA ZA NAPINJANJE SIDRA


## UGRAĐENA SIDRA UZDUŽ ZIDA

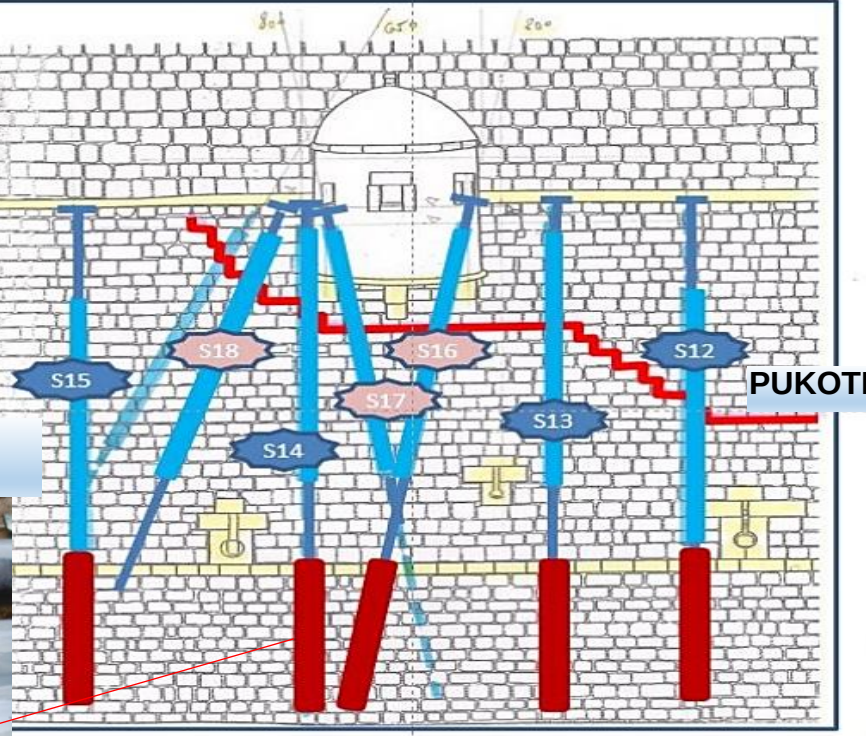
# OPREMA ZA BUŠENJE

spegra

# DEFORMACIJE ZIDA UZ STRAŽARNICU

## IZVEDENO STANJE SNACIJE




PREDZIĐE PILE-BOKAR: OJAČANJE STRAŽARNICE

PUKOTINA U ZIDU

PUKOTINA

## NAGNUTE KAMENE KONZOLE KOJE PODUPIRU STRAŽARNICU

www.spegra.hr

spegra

## SIDRENA PLOČA S PRIKLJUČCIMA ZA INJEKTIRANJE

## ZRAKASTO SIDRO ZA OSLANJANJE CIJEVI

spegra

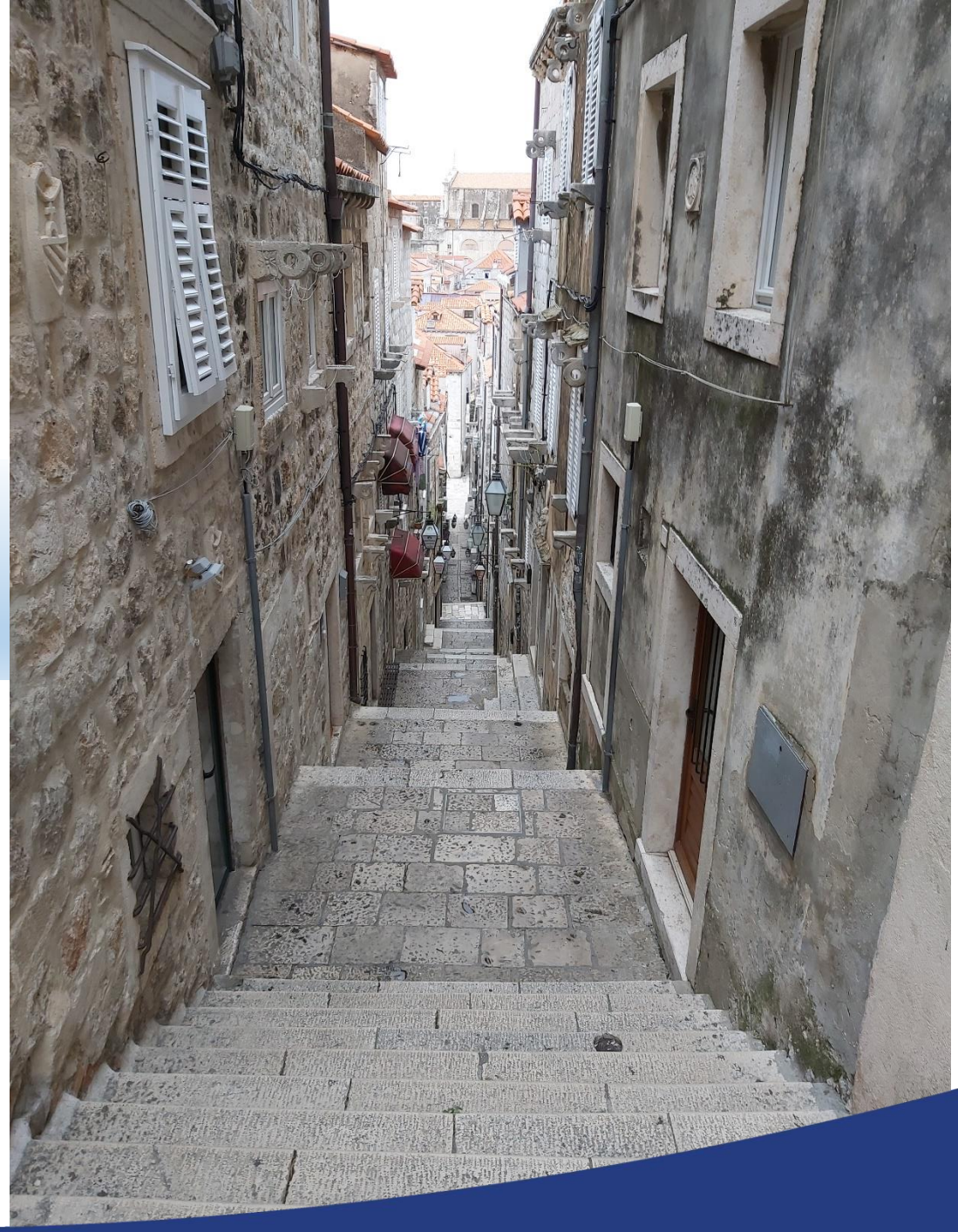
ZRAKASTO SIDRO NA KONTAKTU S INJEKCIJSKOM ČARAPOM TIP „SPEGRA”

ČELIČNA CIJEV KAO DODATNO OJAČANJE

KOMPLETNO SIDRO S ČARAPOM TIP „SPEGRA”

www.spegra.hr

# Aseizmička sanacija u povijesnoj jezgri Dubrovnika



www.spegra.hr

## MEHANIZMI LOMA KOD GRAĐEVINA U NIZU -BLOKOVI (prema Giuffre,1993)

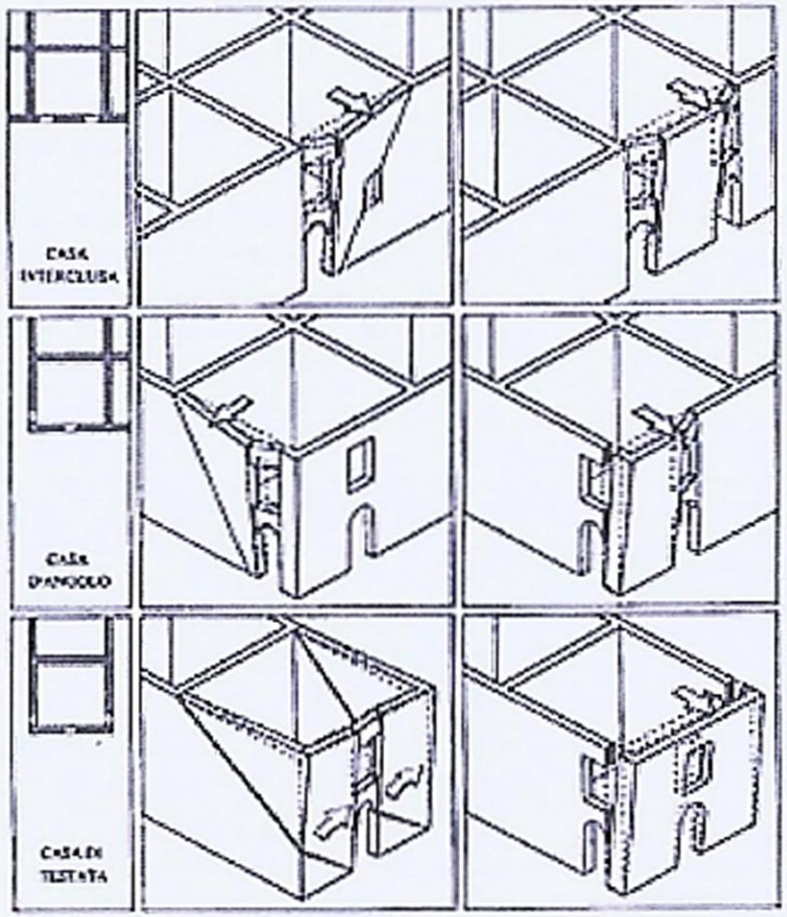


Fig. 46. Failure mechanism of a building inside a row [Giuffrè, 1993].

**I ZMEĐU ZGRADA U NIZU-BLOKU**

**NA UGLU NIZA-BLOKA**

**NA ČELU NIZA-BLOKA**

## SAMOSTOJEĆE GRAĐEVINE

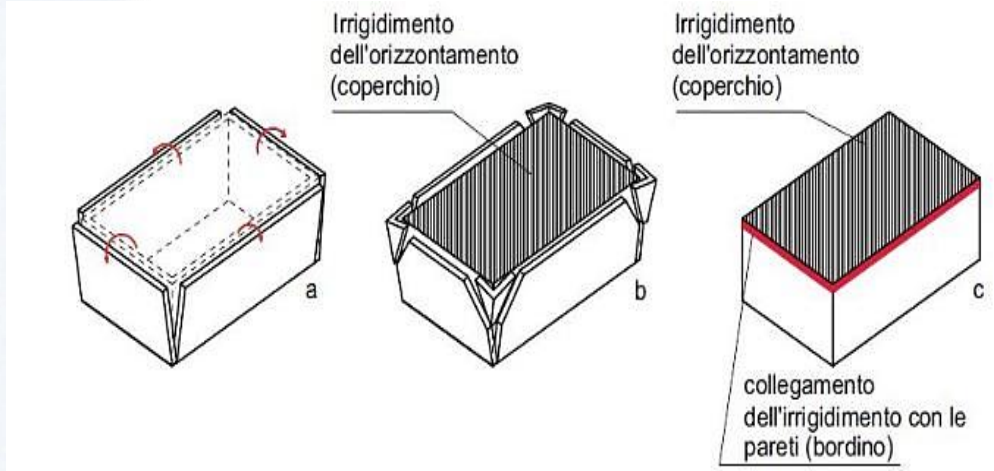
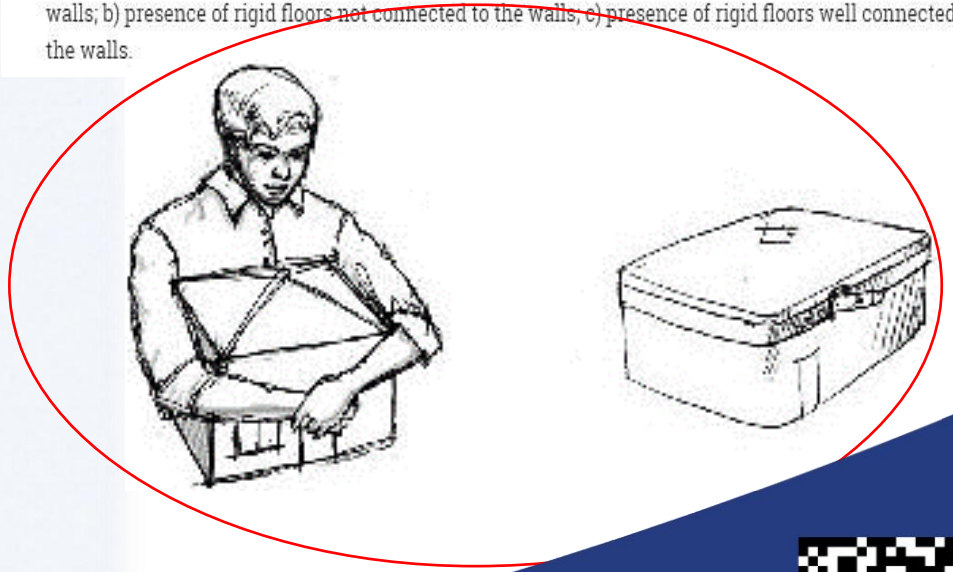


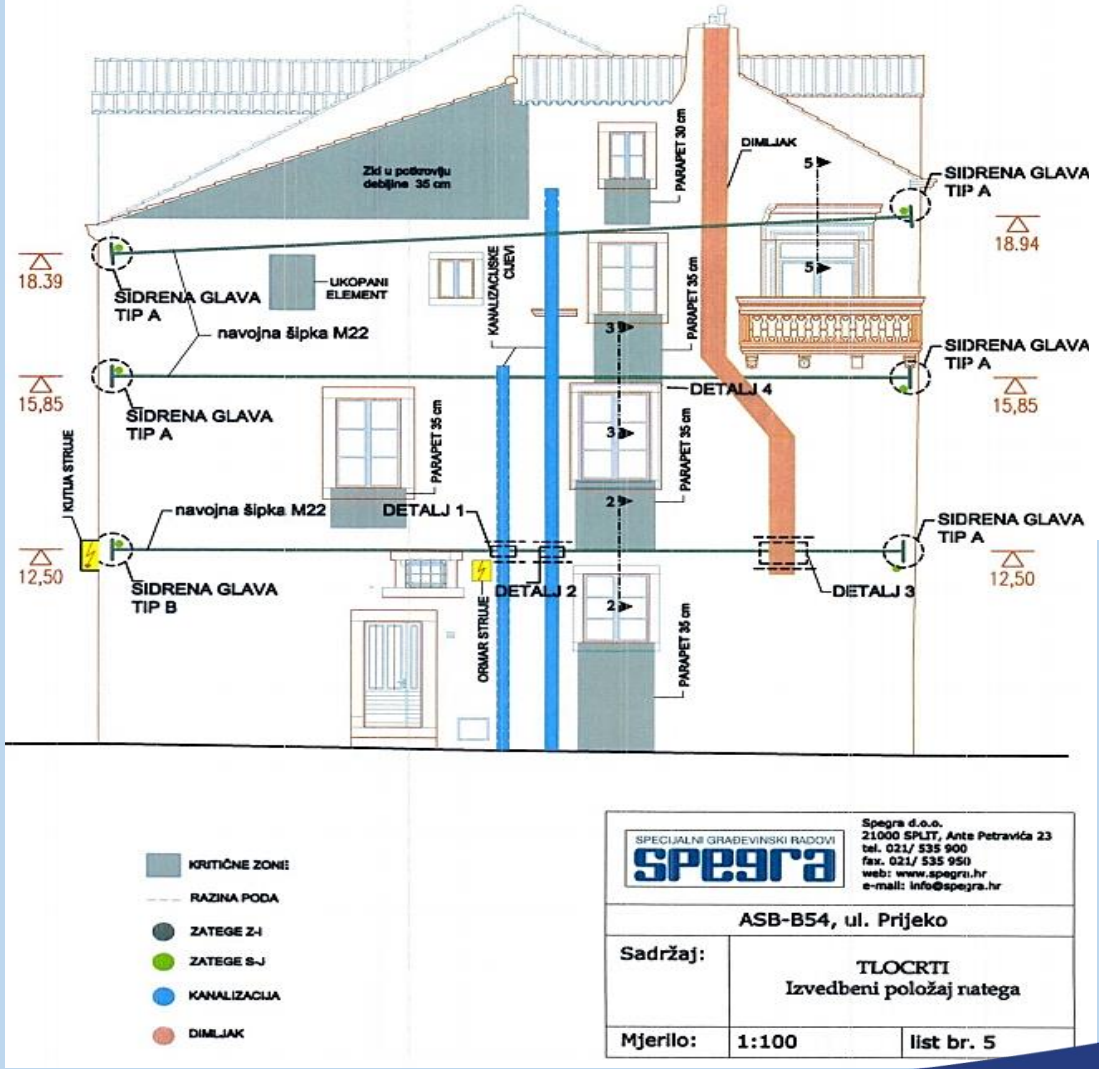

Fig. 1 Behavior of a masonry factory. a) Absence of rigid horizontal lines and connections between the walls; b) presence of rigid floors not connected to the walls; c) presence of rigid floors well connected to the walls.



# ROTIRAJUĆI VIDEO PRIKAZ BLOKA B-54

www.spegra.hr

## 3.5 Izvedbeni položaj natega-vertikalna projekcija




SPECIJALNI GRAĐEVINSKI RADOVI spegra

Spegra d.o.o.
21000 SPLIT, Ante Petravića 23
tel. 021/ 535 900
fax. 021/ 535 950
web: www.spegra.hr
e-mail: info@spegra.hr

ASB-B54, ul. Prijeko

| Sadržaj: | TLOCRTI<br>Izvedbeni položaj natega | |
|---|---|---|
| Mjerilo: | 1:100 | list br. 5 |

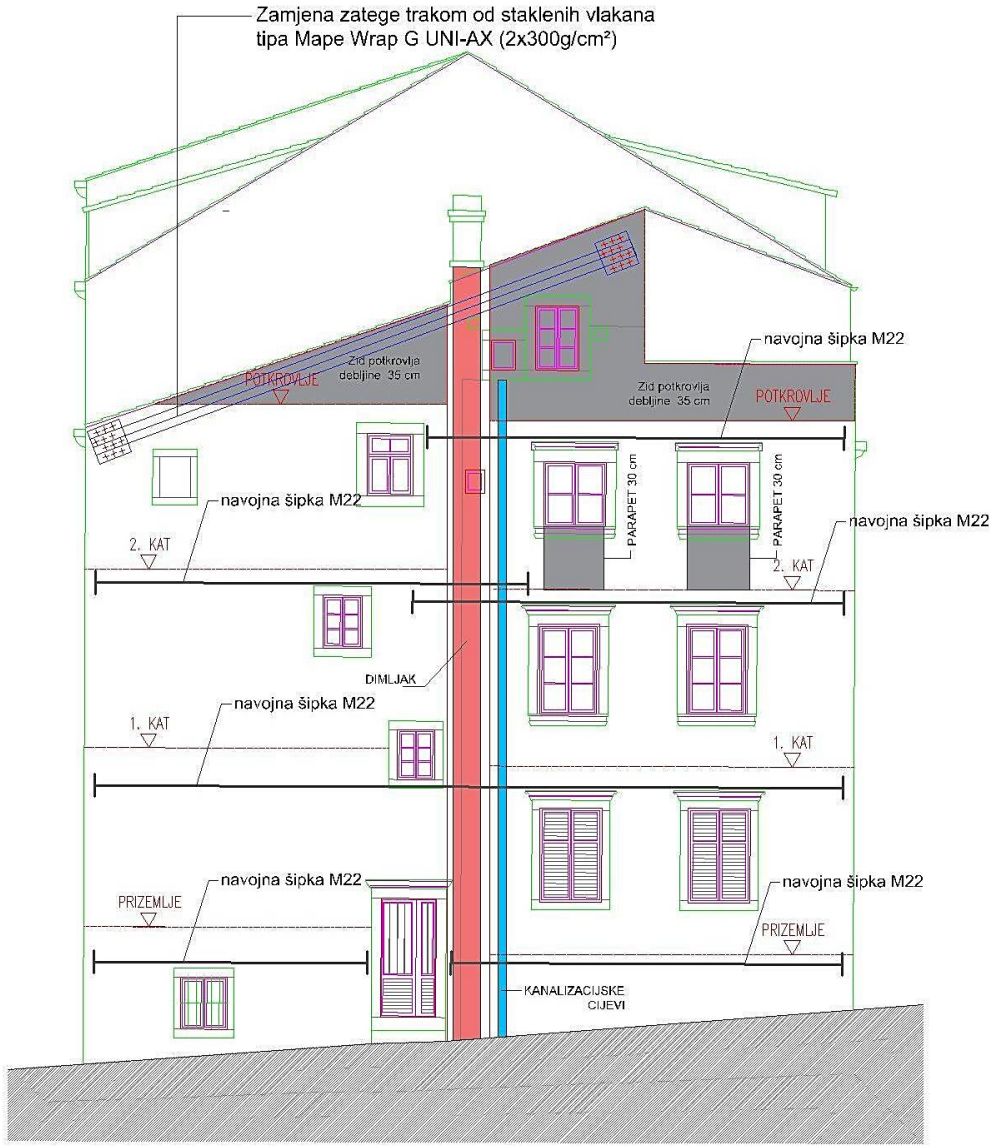
## PROJEKTIRANO STANJE

## B 54-SJEVERNO PROČELJE

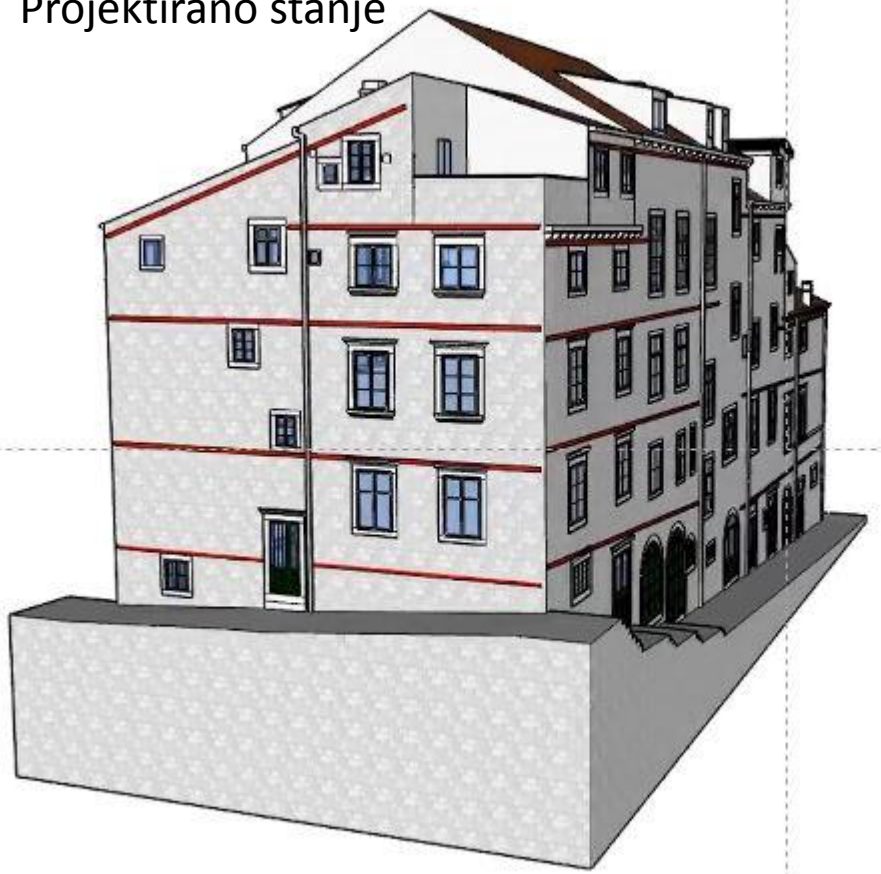
# ROTIRAJUĆI VIDEO PRIKAZ BLOKA B-39

www.spegra.hr

# B-39 Izvedbeni položaj natega-vertikalna projekcija




Projektirano stanje



**SJEVERNO PROČELJE B39**

www.spegra.hr

# B39 ZAPADNO PROČELJE STVARNO STANJE-sjeverni dio

Parapetni zidovi 20-30cm

navojna šipka M22

navojna šipka M22

navojna šipka M22

navojna šipka M22

KANALIZACIJSKE CIJEVI

KANALIZACIJSKE CIJEVI

**NAPOMENA: IZVEDENO STANJE U PRIPREMI**

## PROJEKTIRANO STANJE

B39 ZAPADNO PROČELJE-ukupno

www.spegra.hr








# DETALJI KOD UGRADNJE FRP KOMPOZITA


6 5 2005


# DETALJI KOD BUŠENJA NATEGA

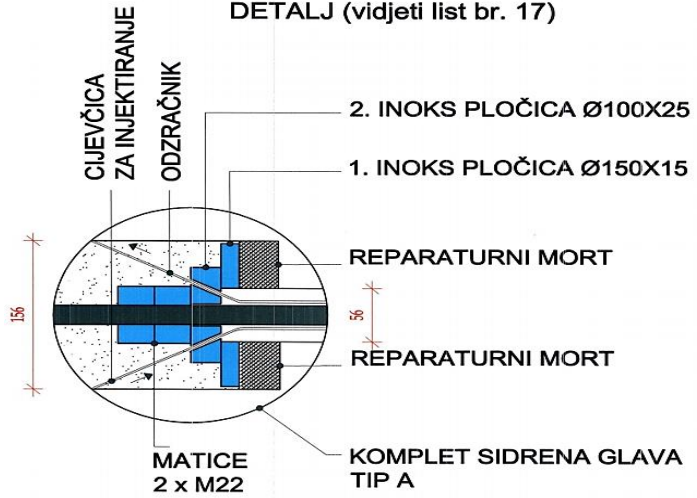


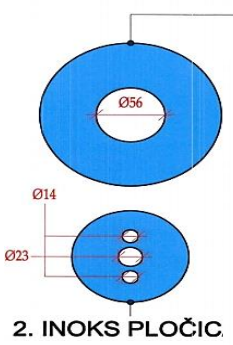
spegra

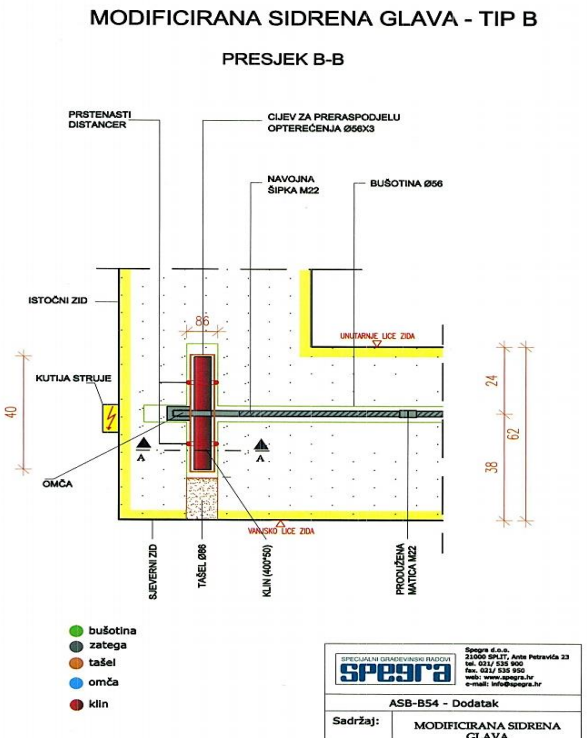
## DETALJI KOD BUŠENJA NATEGA

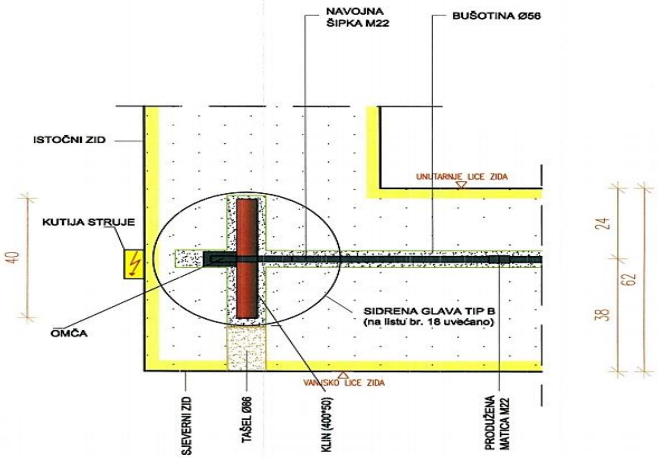

4.8 SIDRENA GLAVA TIP (B)

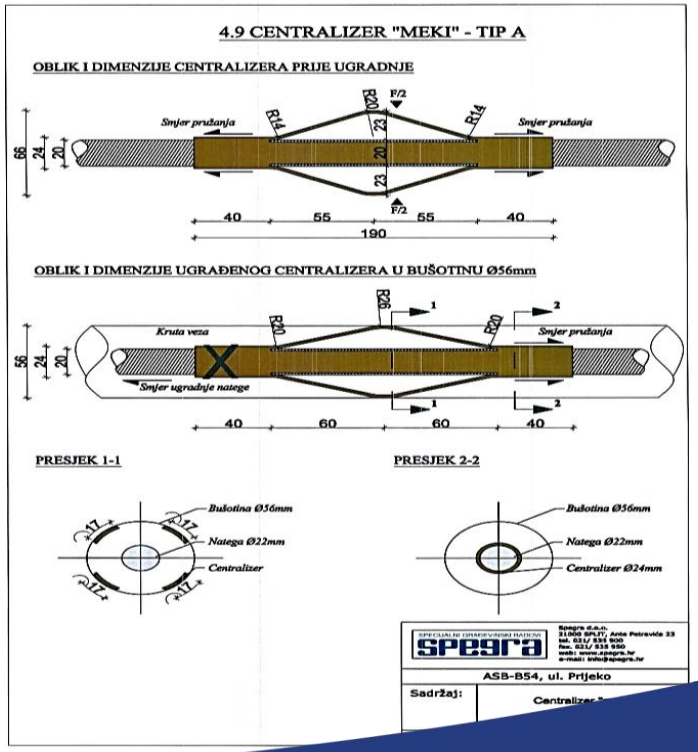
# IZVEDBENI DETALJI

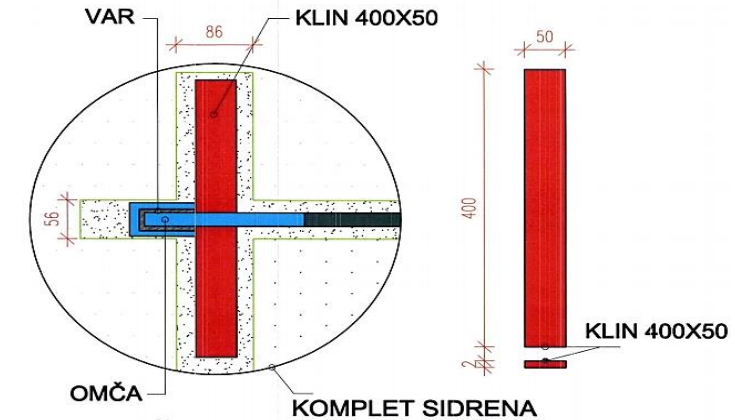


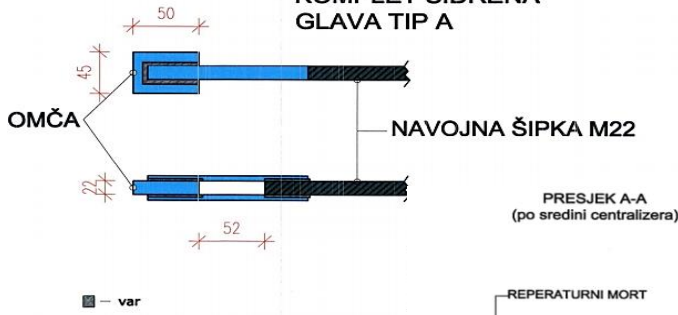



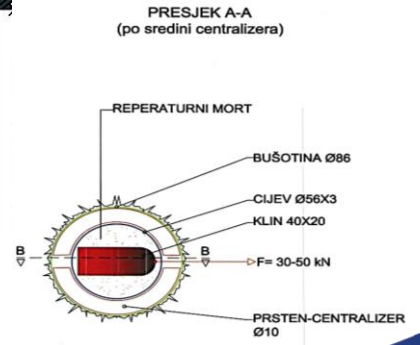



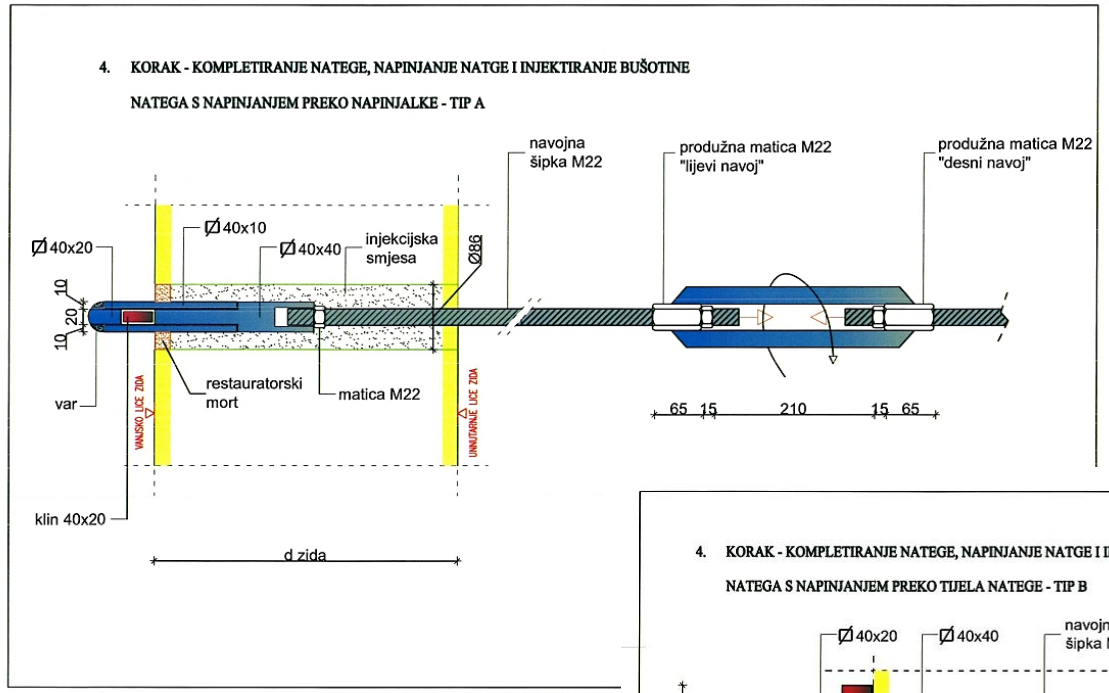



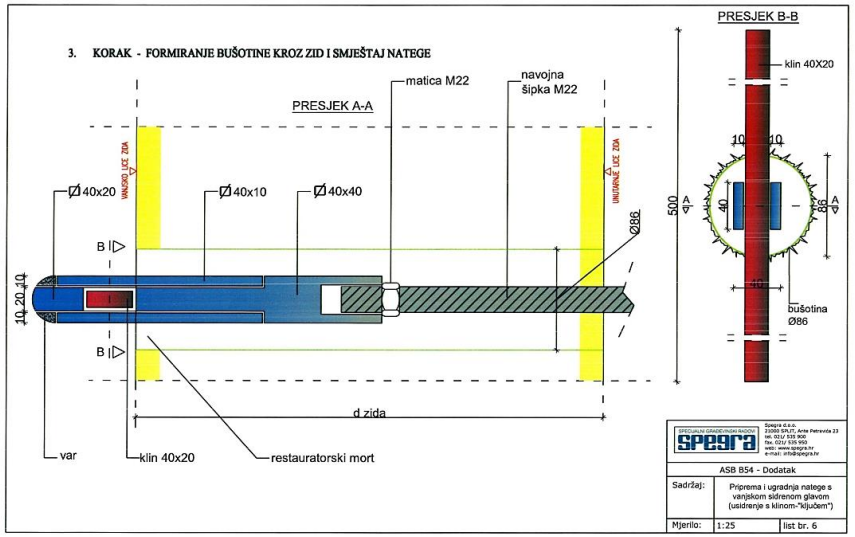



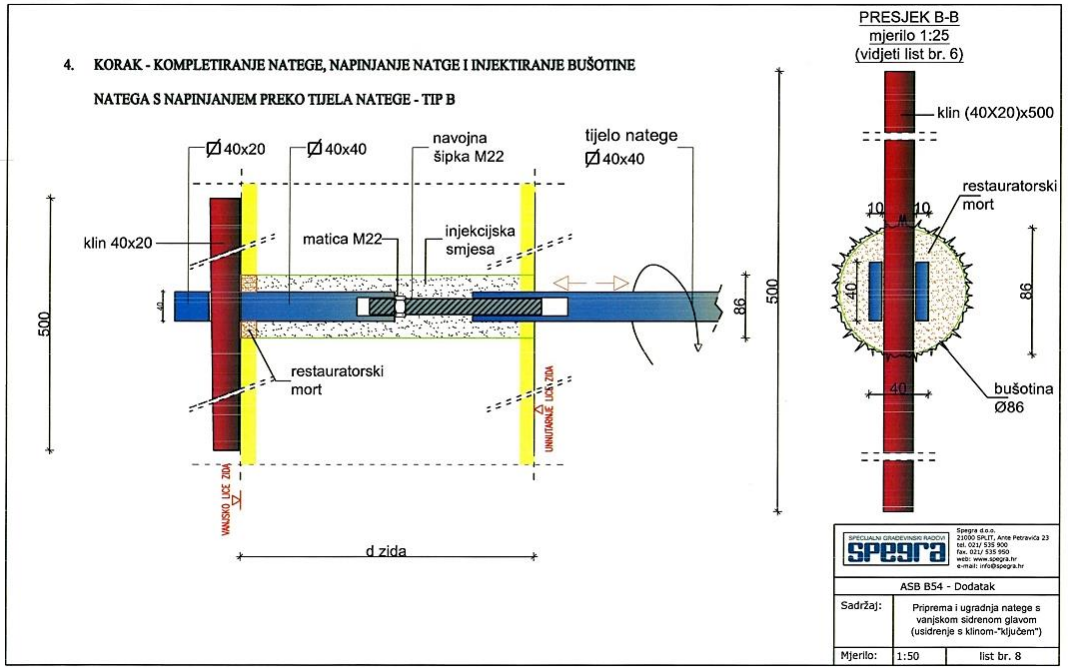

| SPECIJALNI GRAĐEVINSKI RADOVI spegra | Spegra d.o.o. 21000 SPLIT, Ante Petravića 23 tel. 021/ 535 900 fax. 021/ 535 950 web: www.spegra.hr e-mail: info@spegra.hr |
|---|---|
| ASB-B54 - Dodatak | |
| Sadržaj: | MODIFICIRANA SIDRENA GLAVA TIP B |
| Mjerilo: 1:10 | list br. 1 |

www.spegra.hr

# IZVEDBENI DETALJI



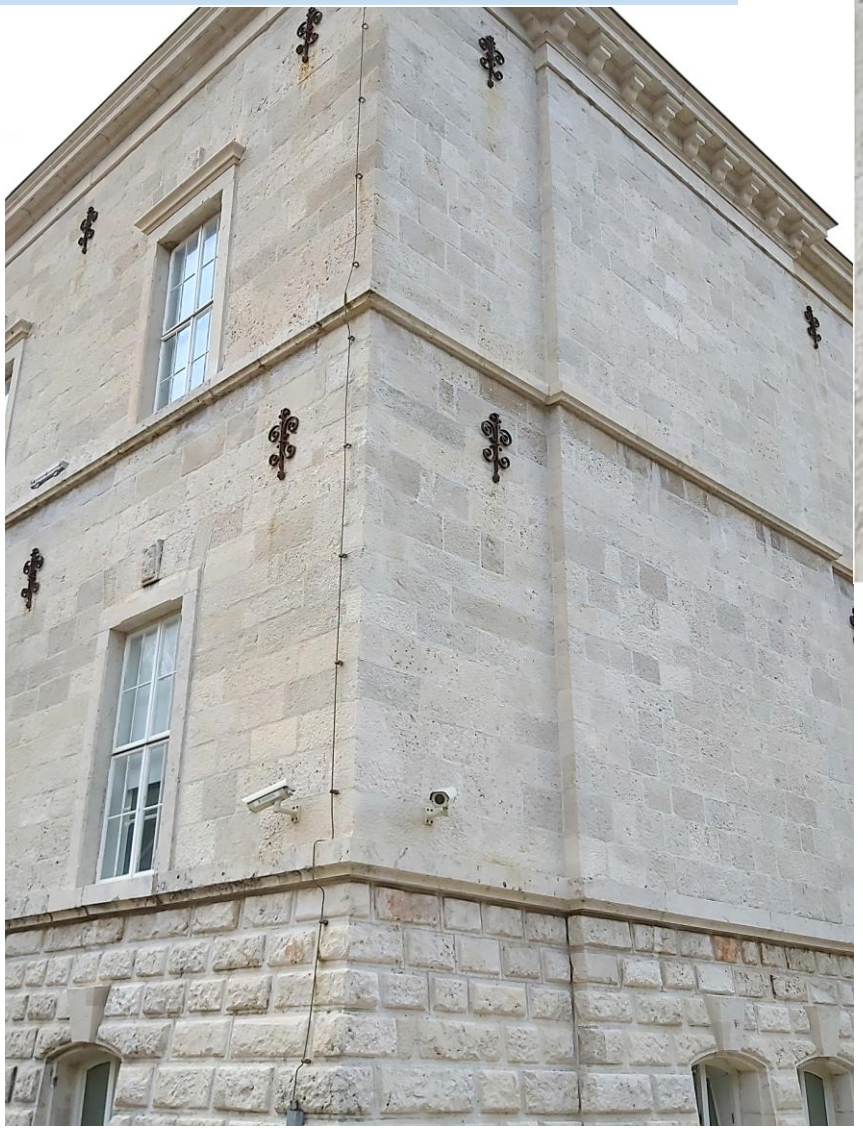




www.spegra.hr



## IZVEDBENI DETALJI

# TIPOVI SIDRENIH VANJSKIH GLAVA



www.spegra.hr

# INJEKTIRANJE KAMENOG ZIĐA







www.spegra.hr

# BISKUPSKA PALAČA, DUBROVNIK

## INTERVENCIJE SA FRP I FRG KOMPOZITIMA

www.spegra.hr





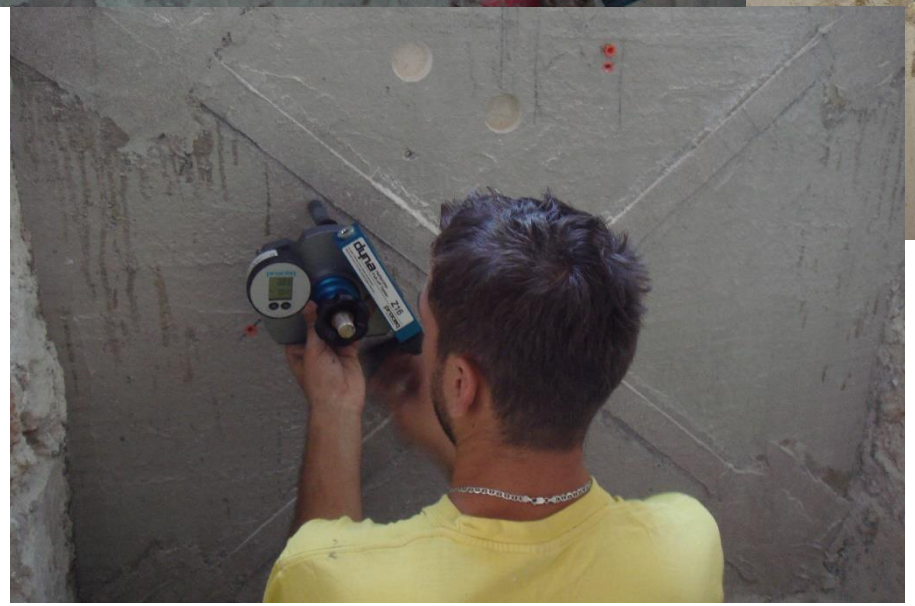




www.spegra.hr







www.spegra.hr








www.spegra.hr



## PROVJERA NOSIVOSTI SIDARA



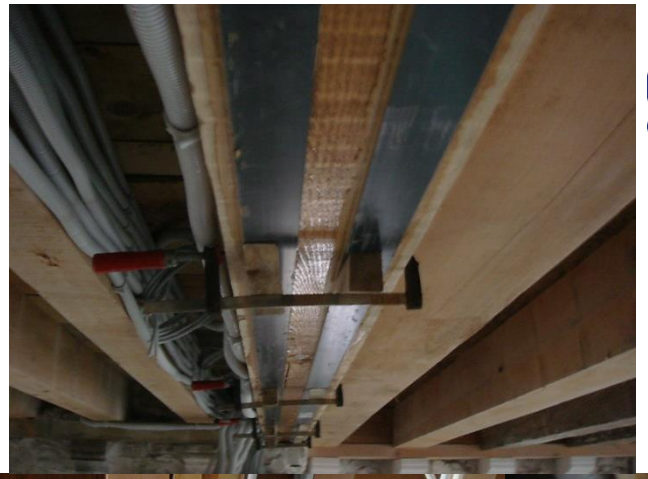
## PROVJERA PRIONLJIVOSTI LAMELA


www.spegra.hr




spegra

www.spegra.hr



spegra

www.spegra.hr

spegra

# KNEŽEV DVOR, DUBROVNIK

## RESTAURACIJA KAMENIH STUPOVA

www.spegra.hr

spegra

## VELIKI STUPOVI U PRIZEMLJU

## DVOJNI STUPOVI NA KATU

POSTAMENT







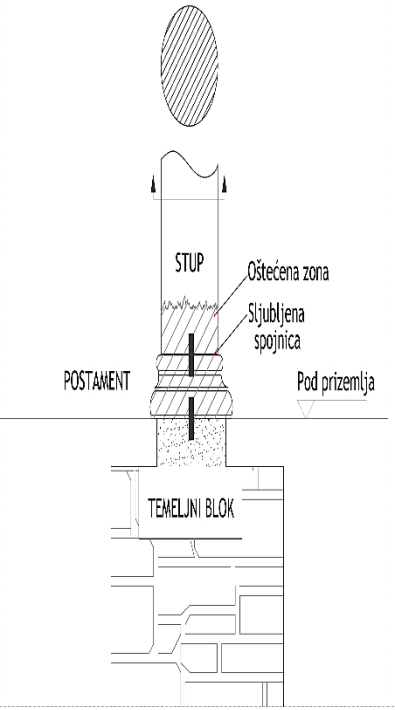
www.spegra.hr

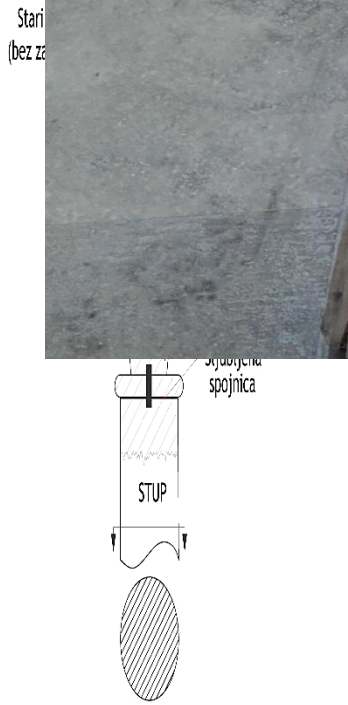
spegra

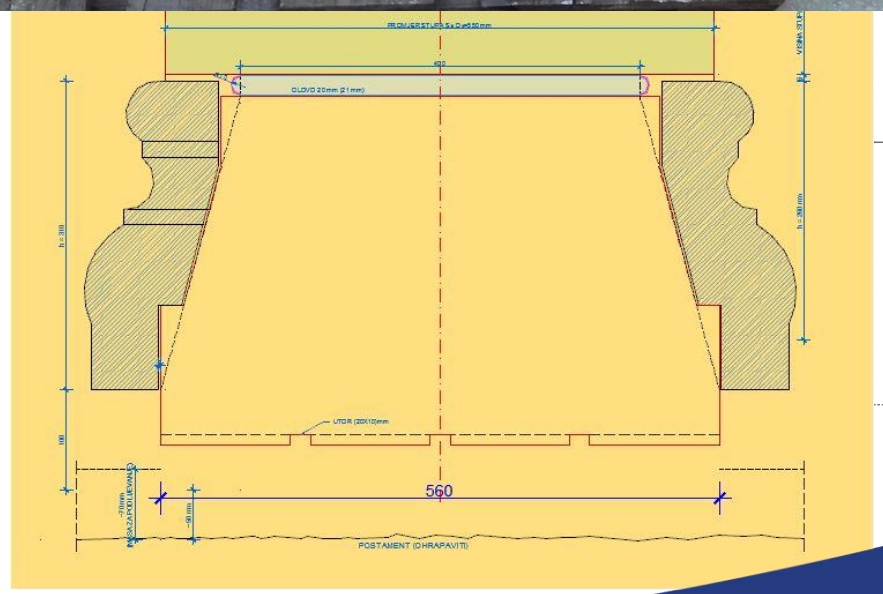
**ODVAJANJE BAZE OD STUPA KOD VELIKIH STUPOVA**

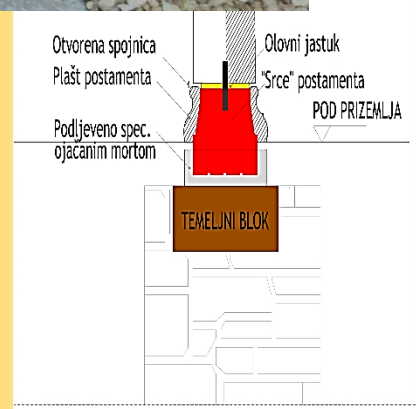
www.spegra.hr

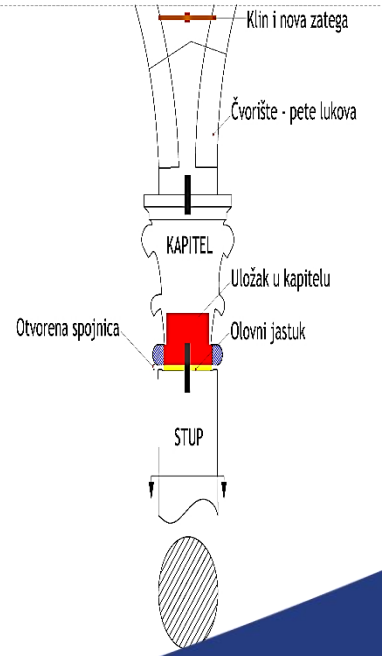
# VELIKI STUPOVI-ZATEČENO STANJE POSTAMENTA




www.spegra.hr

DIJAMNATA ŽICA ZA PODSJECANJE „VRATA” ISPOD POSTAMENTA

spegra

POSTUPCI KOD SANACIJE VELIKOG STUPA

UGRAĐEN RESTAURIRANI POSTAMENT

www.spegra.hr

# DVOJNI STUPOVI-ZATEČENO STANJE POSTAMENTA

# DVOJNI STUPOVI-RADOVI RESTAURACIJE U TIJEKU

www.spegra.hr


www.spegra.hr

www.spegra.hr

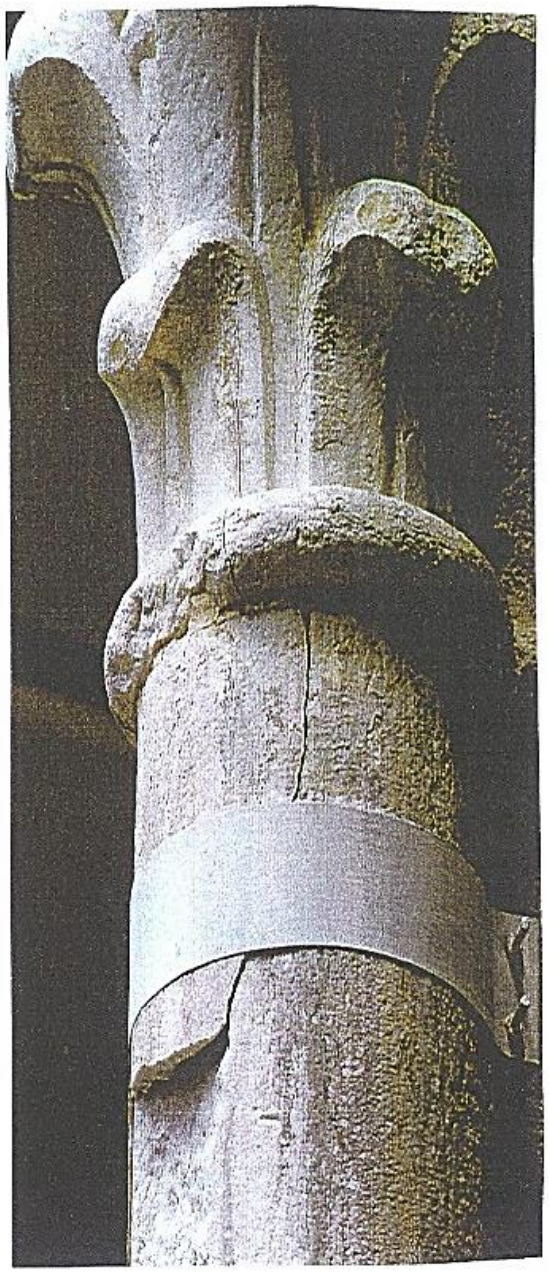
# DVOJNI STUPOVI - STANJE NAKON RESTAURACIJE POSTAMENTA

www.spegra.hr

*Produženi inox ležajevi stupova kata – primjenjuje se u slučaju potpune raspucalosti kamene baze*

**ULOŠCI ZA POSTAMENT**

www.spegra.hr



# KNEŽEV DVOR DUBROVNIK

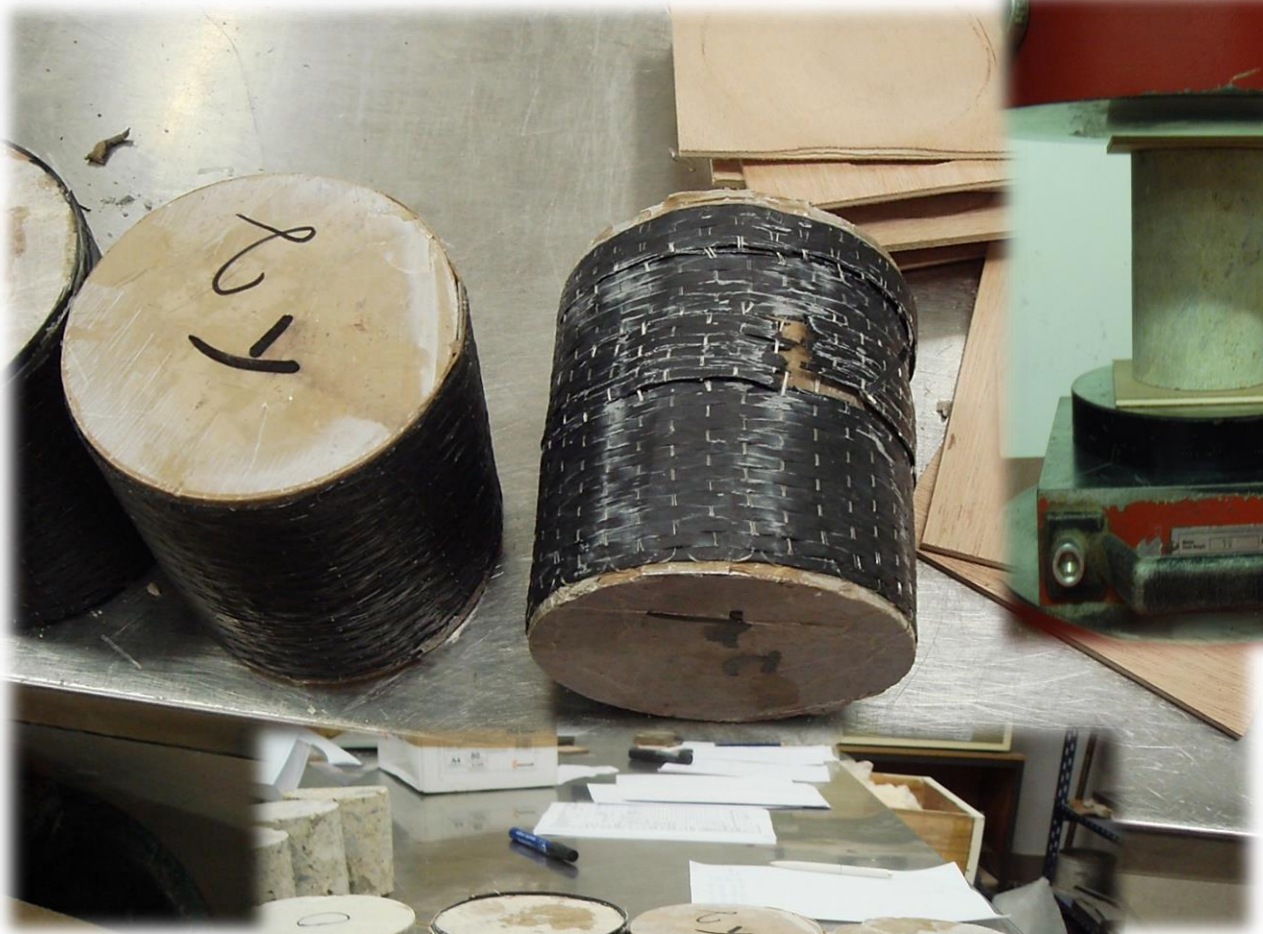
## HITNA INTERVANCIJA S FRP KOMPOZITIMA

www.spegra.hr


PRIPREMLJENI UZORCI ZA ISPITIVANJE SA RAZLIČITIM METODAMA UMOTAVANJA

spegra

www.spegra.hr




www.spegra.hr

# METODA UMOTAVANJA S PREDGOTOVLJENOM LJUSKOM OD CFRP-A

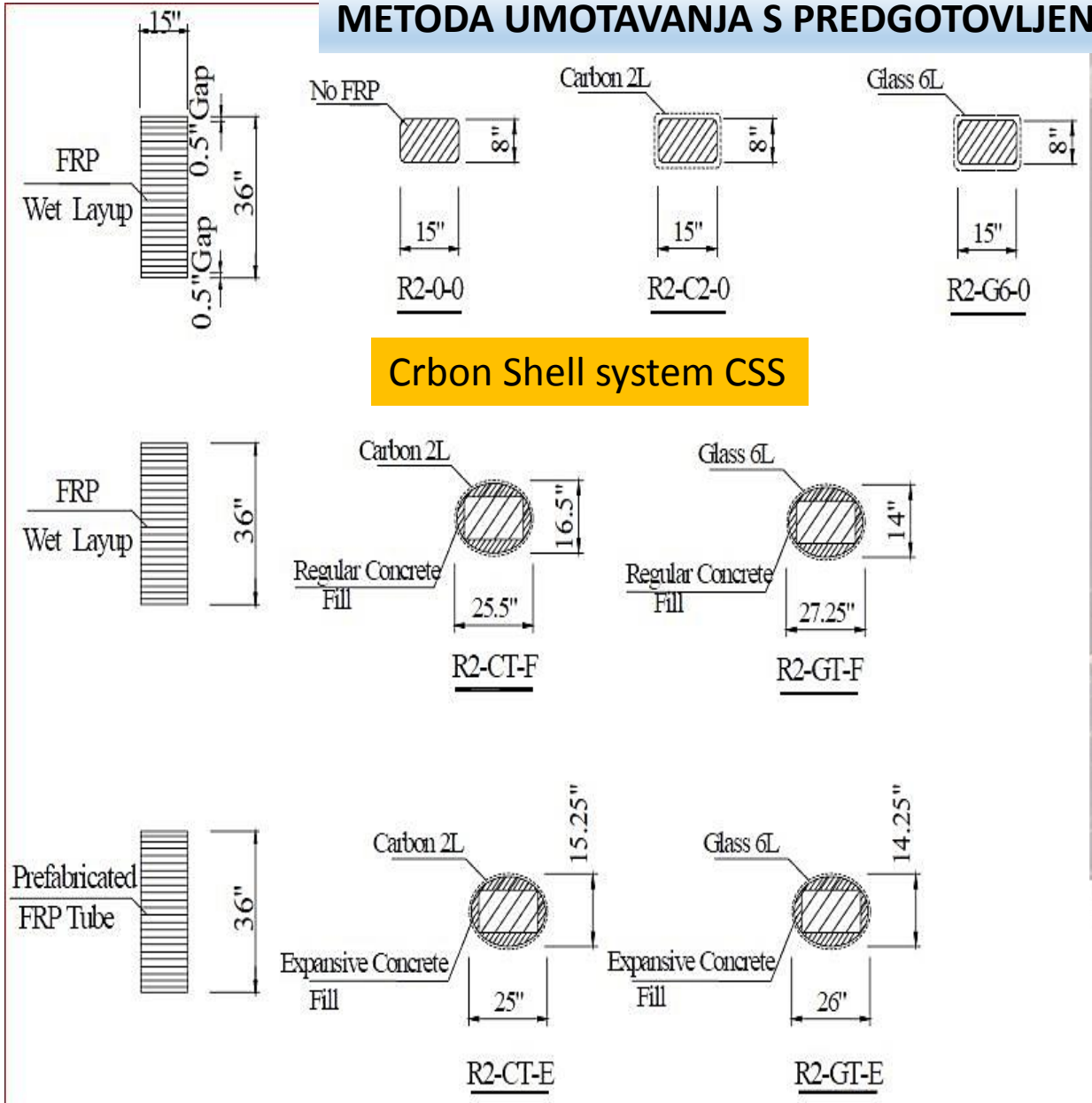



Figure 3.6(c) Wrapping methods for rectangular columns (1)

Crbon Shell system CSS

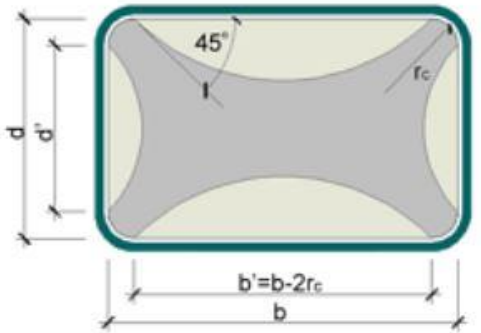
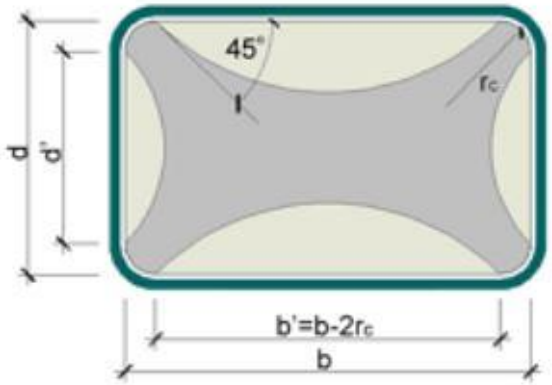


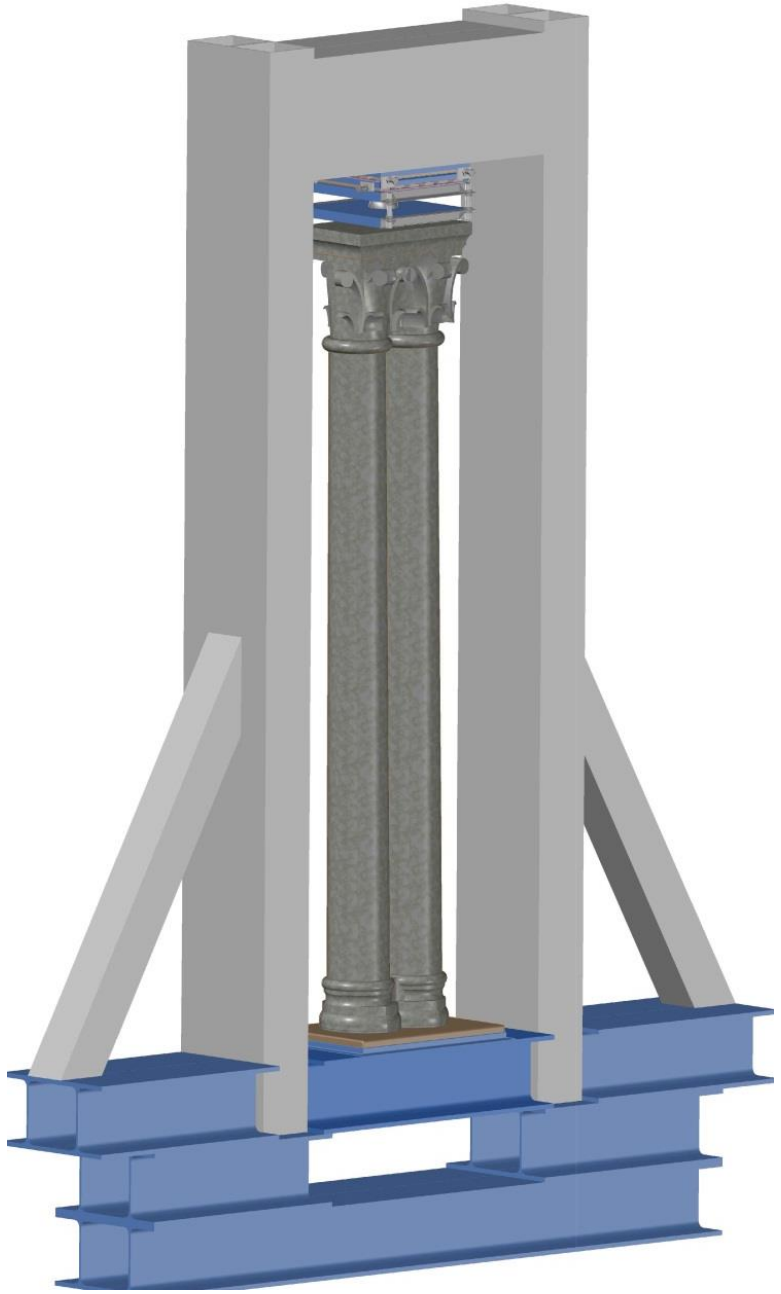

Figure 3.7(d) Casting of expansive cement concrete (4th step)

# IZRADA POMOĆNOG KAMENOG ELEMENTA U OBLKU ELIPSE ZA UTEZANJE IZNAD KAPITELA




www.spegra.hr

www.spegra.hr



# KNEŽEV DVOR, DUBROVNIK

## MODELSKA ISPITIVANJA STUPOVA U RAZMIJERI 1:1

www.spegra.hr

spegra

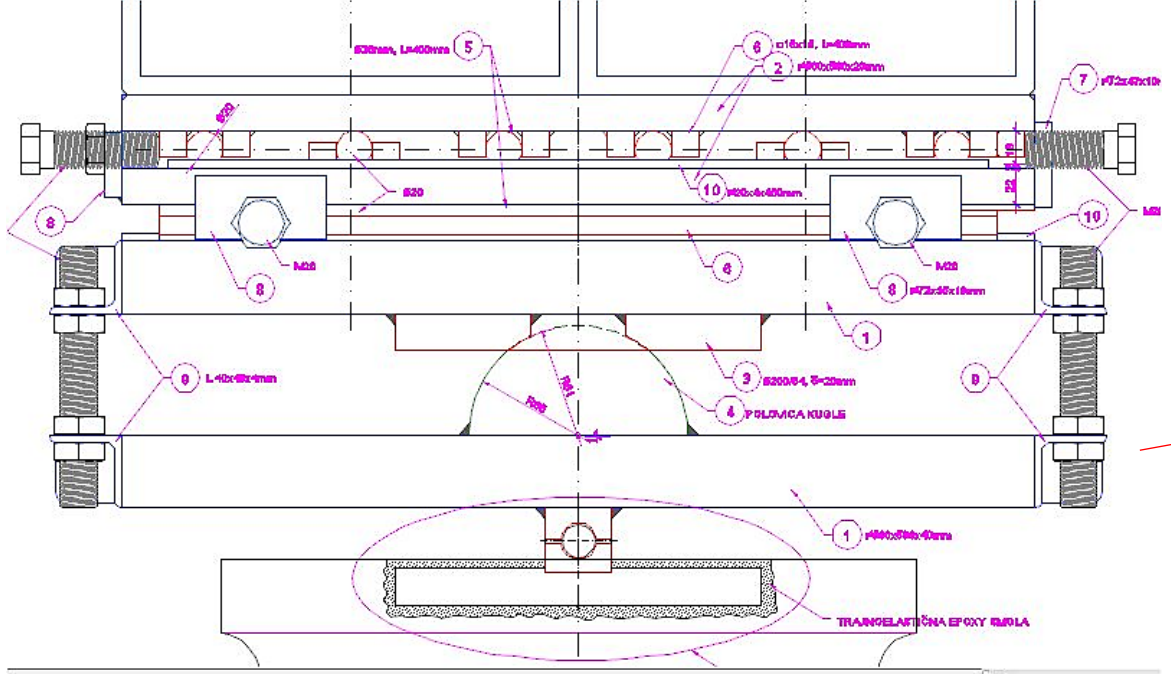
# KOMPLETIRANI MODELI

PROTOTIP MODELA

UDVOJENI STUPOVI NA KATU

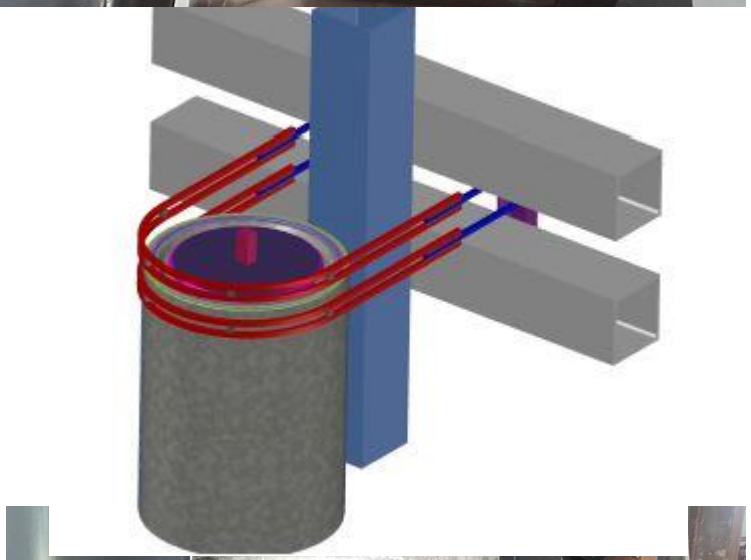
VELIKI STUP U PRIZEMLJU

www.spegra.hr




**GENERATOR POMAKA**

www.spegra.hr



www.spegra.hr

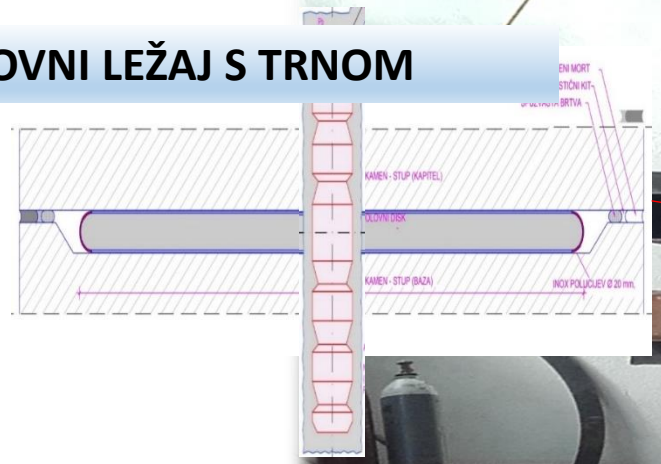
# MODELSKA ISPITIVANJA NOVIH LEŽAJEVA U KAMENIM STUPOVIMA PRIZEMLJA

HIDRAULIČNA PRESA KOJOM SE SIMULIRA VERTIKALNO OPTEREĆENJE

**GORNJI LEŽAJ MODELSKOG SKLOPA**

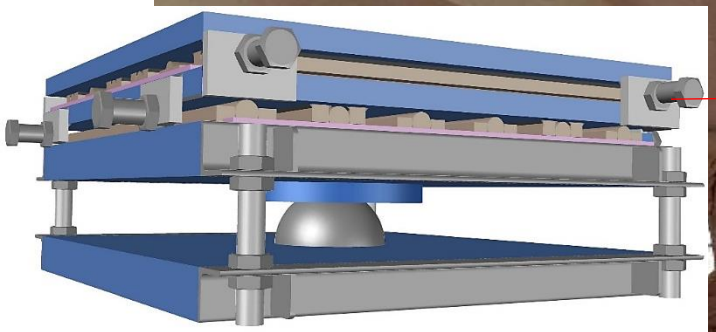
**ČELIČNI PRSTEN S NAVOJOM KOJIM SE SIMULIRA HORIZONTALNO OPTEREĆENJE**

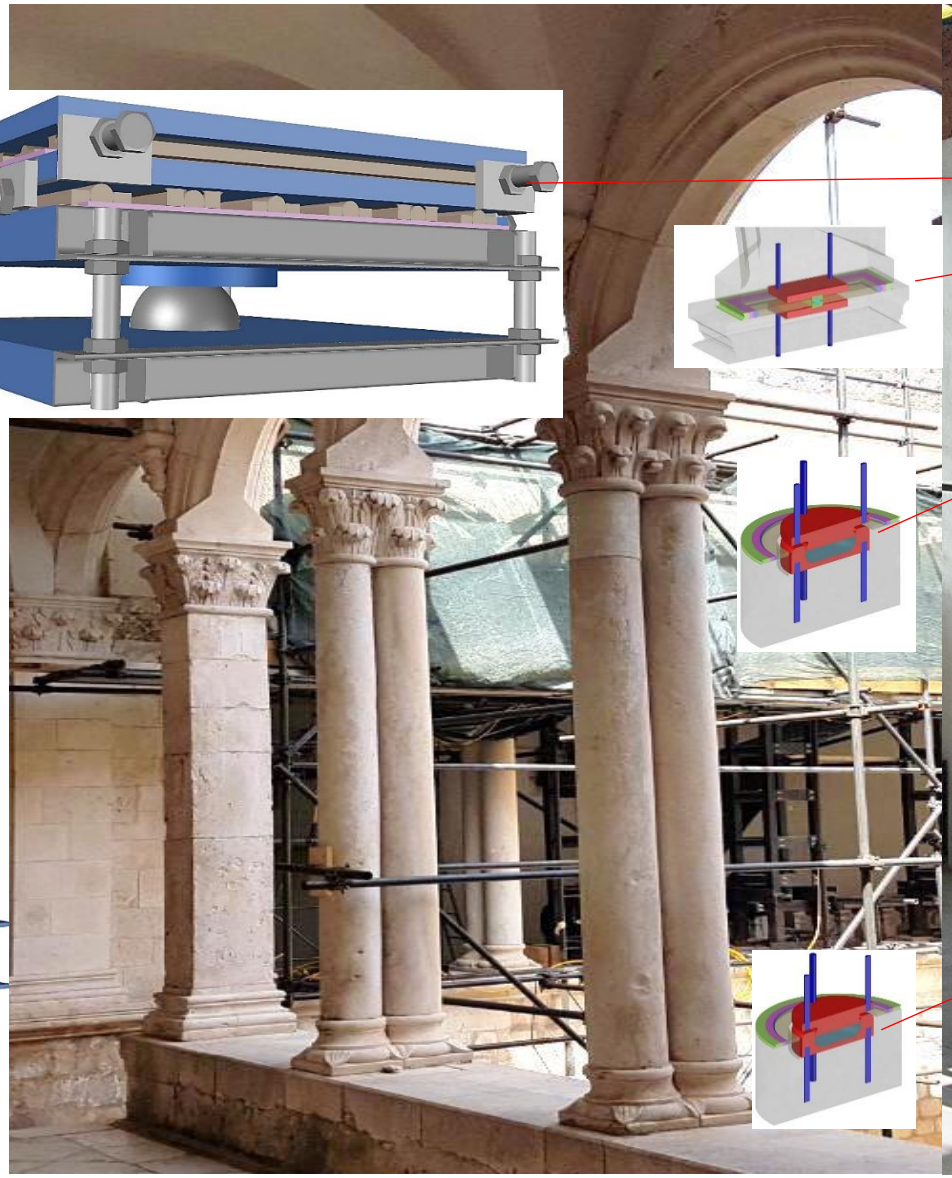
**OLOVNI LEŽAJ S TRNOM**




**DONJI LEŽAJ MODELSKOG SKLOPA**

www.spegra.hr

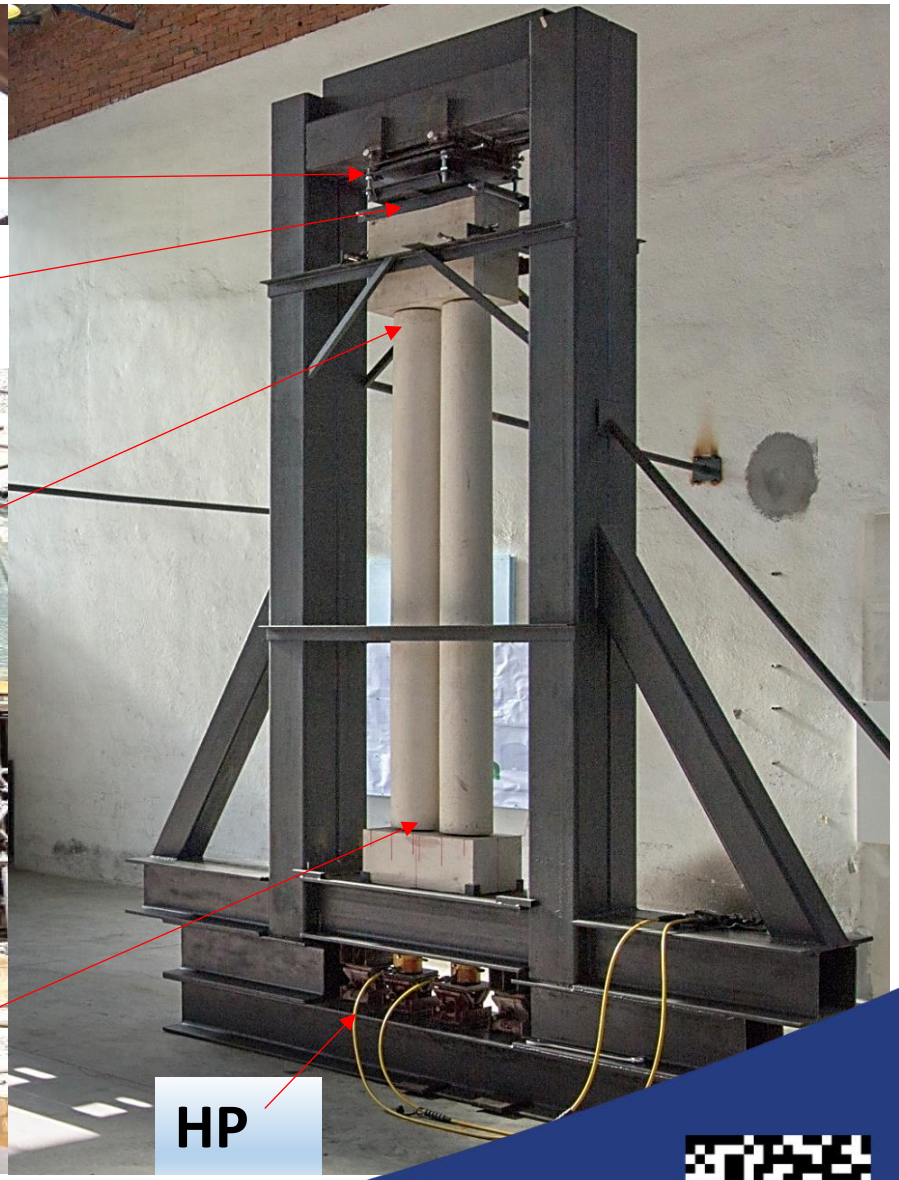












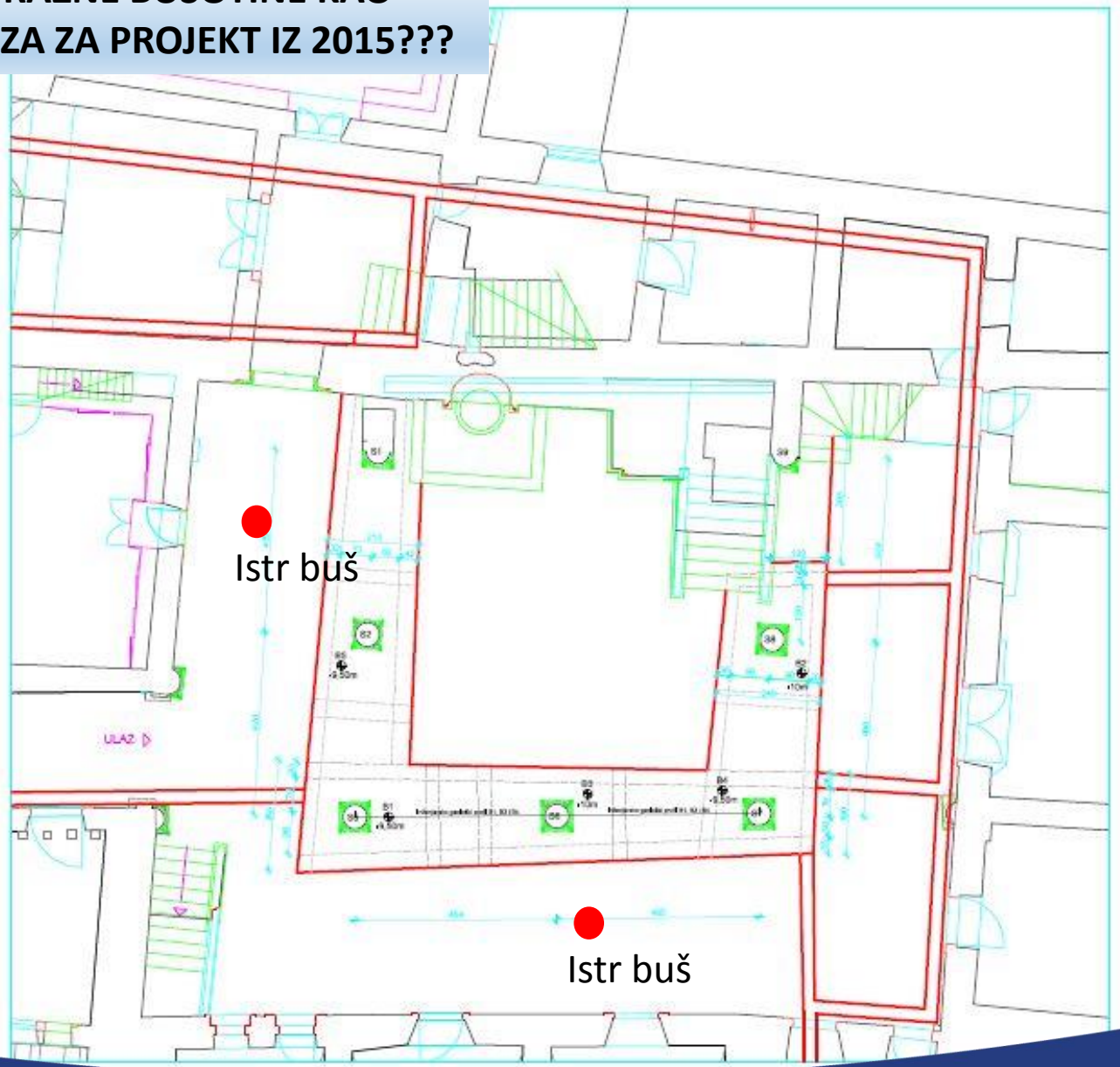

www.spegra.hr

spegra


# KNEŽEV DVOR, DUBROVNIK
## UGRADNJA MIKRO PILOTA

www.spegra.hr

## ISTRAŽNE BUŠOTINE KAO BAZA ZA PROJEKT IZ 2015???

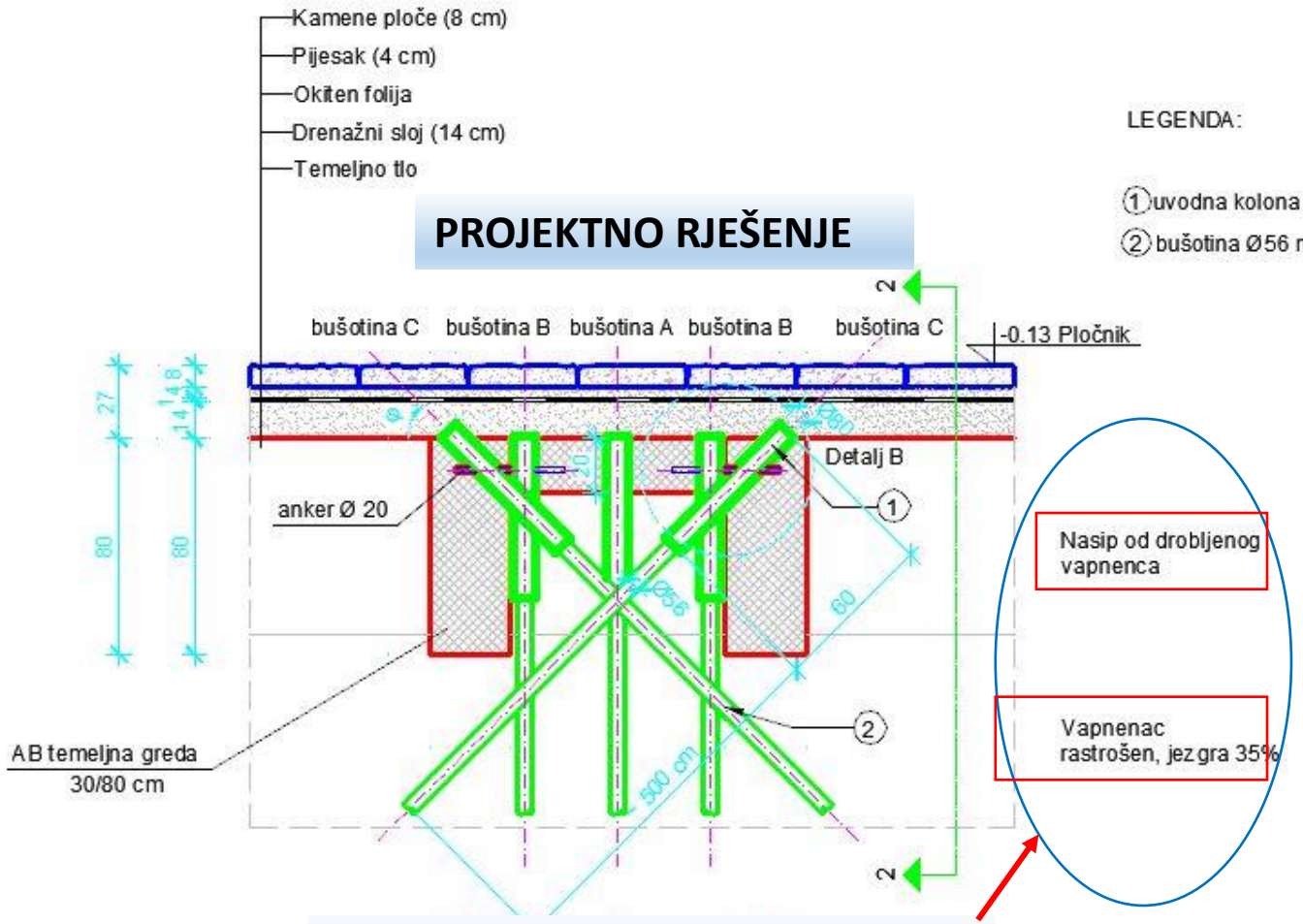




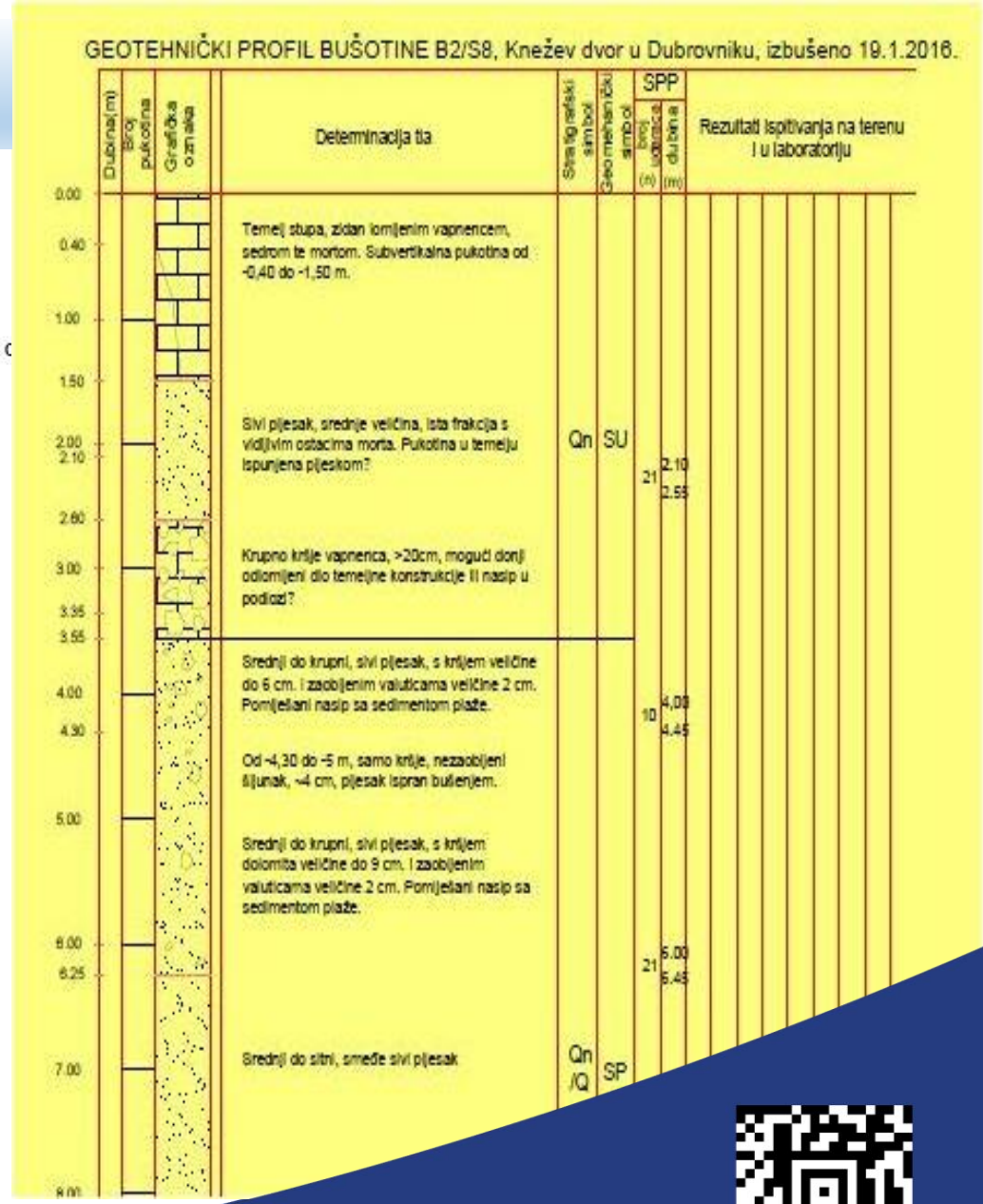
**TLOCRT U PRIZEMLJU ATRIJA SA IZVEDENIM AB UKRUTAMA POSLIJE POTRESA IZ 1979.**

Poprečni presjek temelja
Presjek 1-1
MJ 1:20

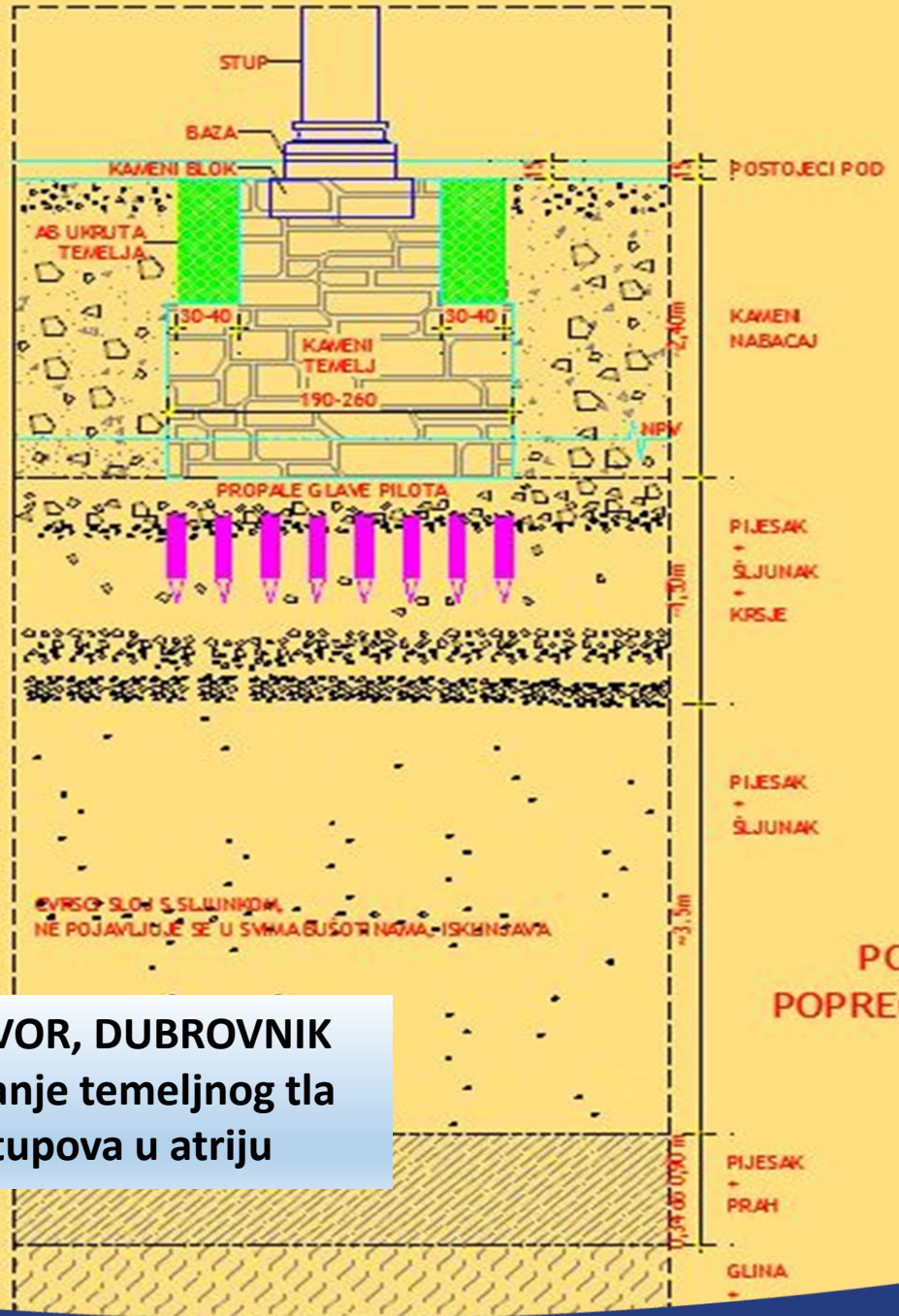
# GEOTEH PROFIL ISTR BUŠOT U TEMELJU STUPA IZ 2016.

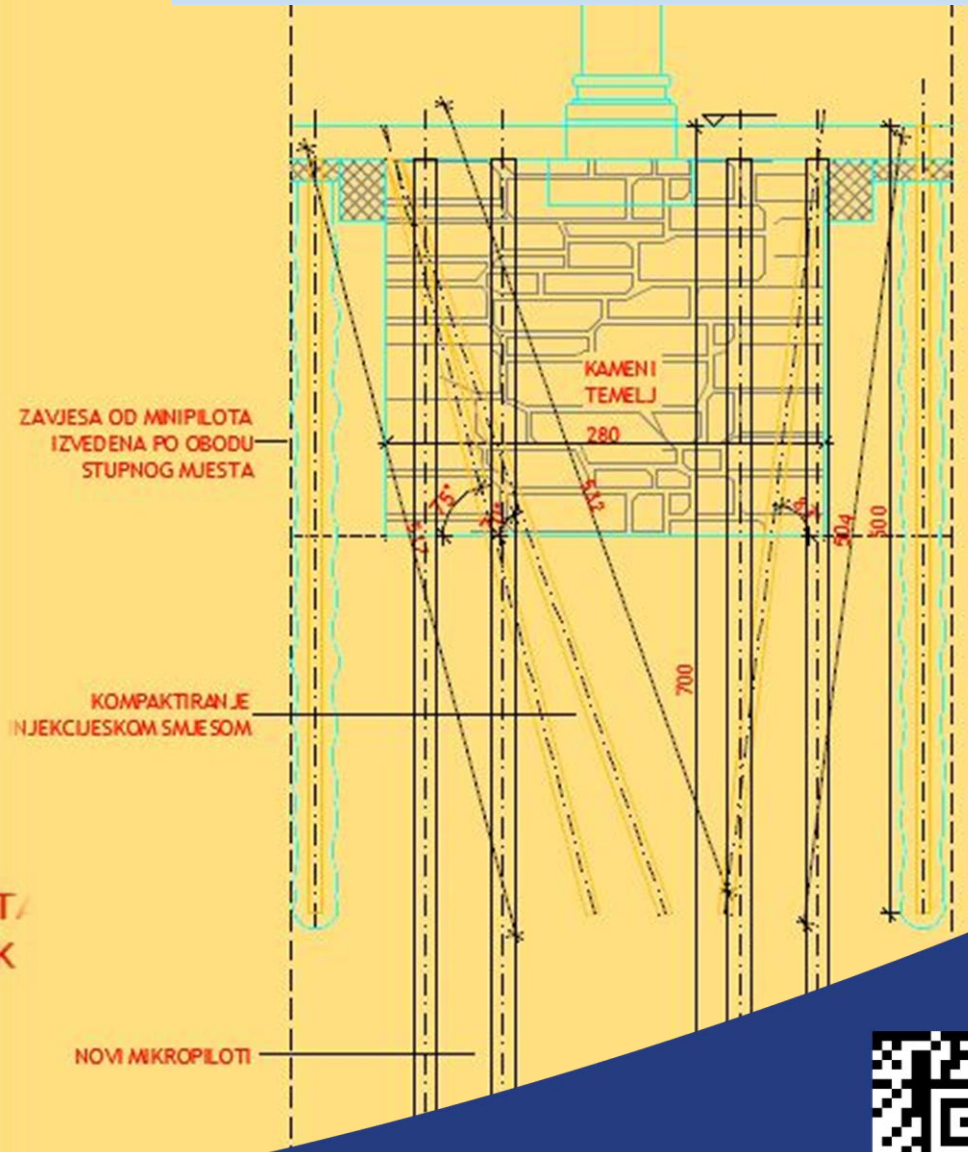



## GEOLOŠKI PRESIJEK KAO PODLOGA ZA PROJEKT PREMA IB VAN ZONE TEMELJA



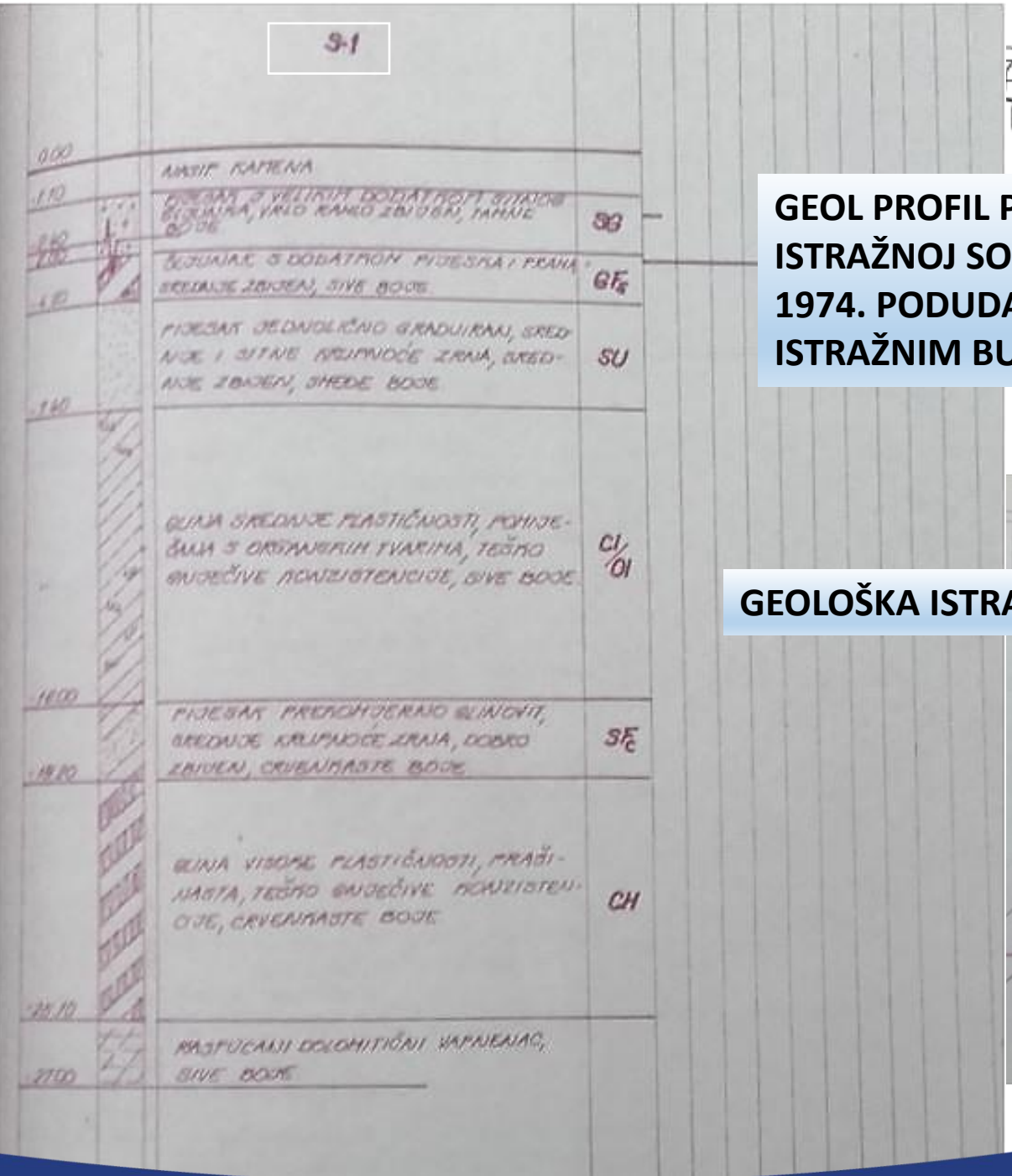
## MODIFICIRANO PROJEKTNO RJEŠENJE IZ 2016.
## S BETONSKIM PILOTIMA




**KNEŽEV DVOR, DUBROVNIK**
**Stvarno stanje temeljnog tla ispod stupova u atriju**

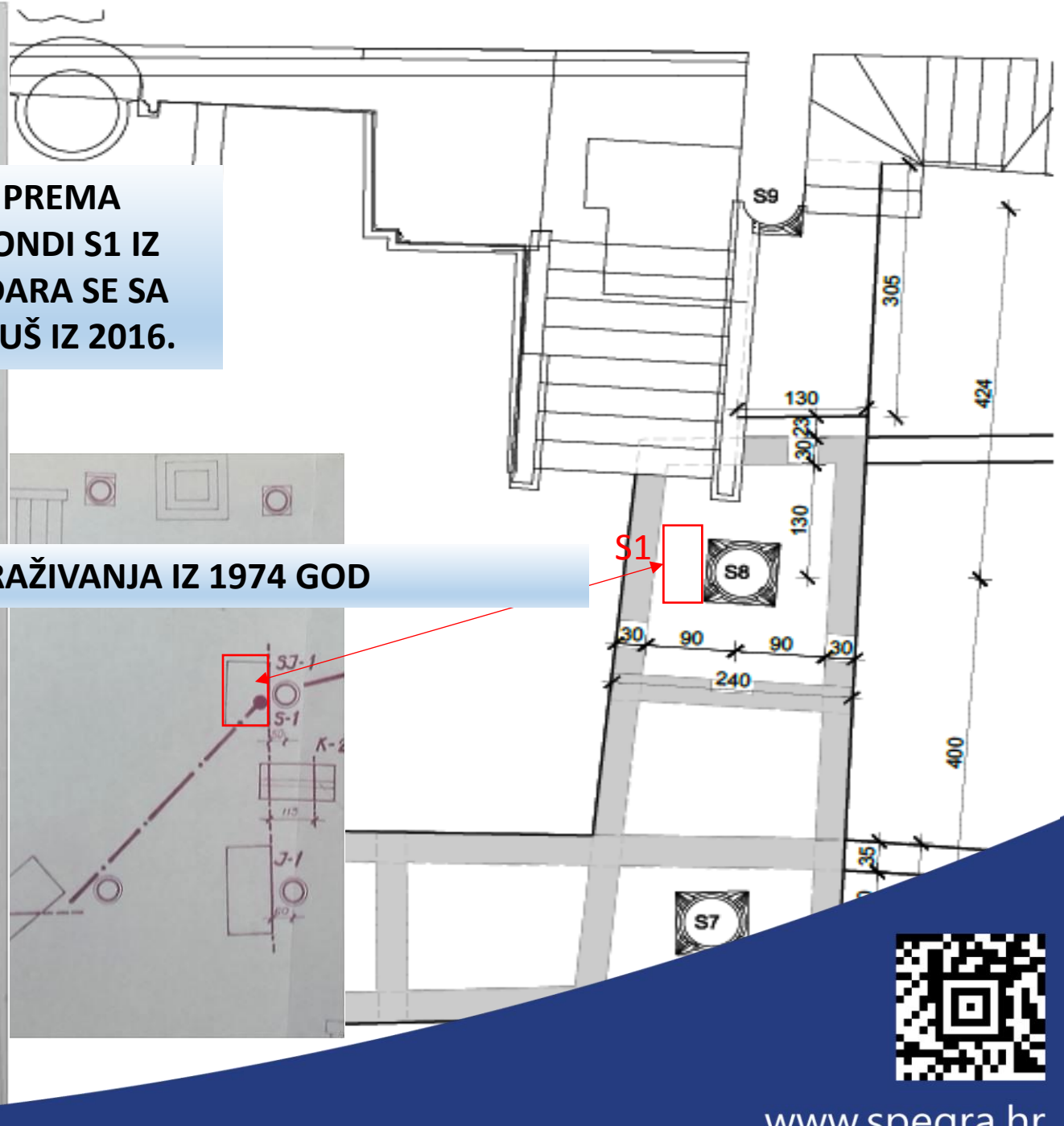
www.spegra.hr



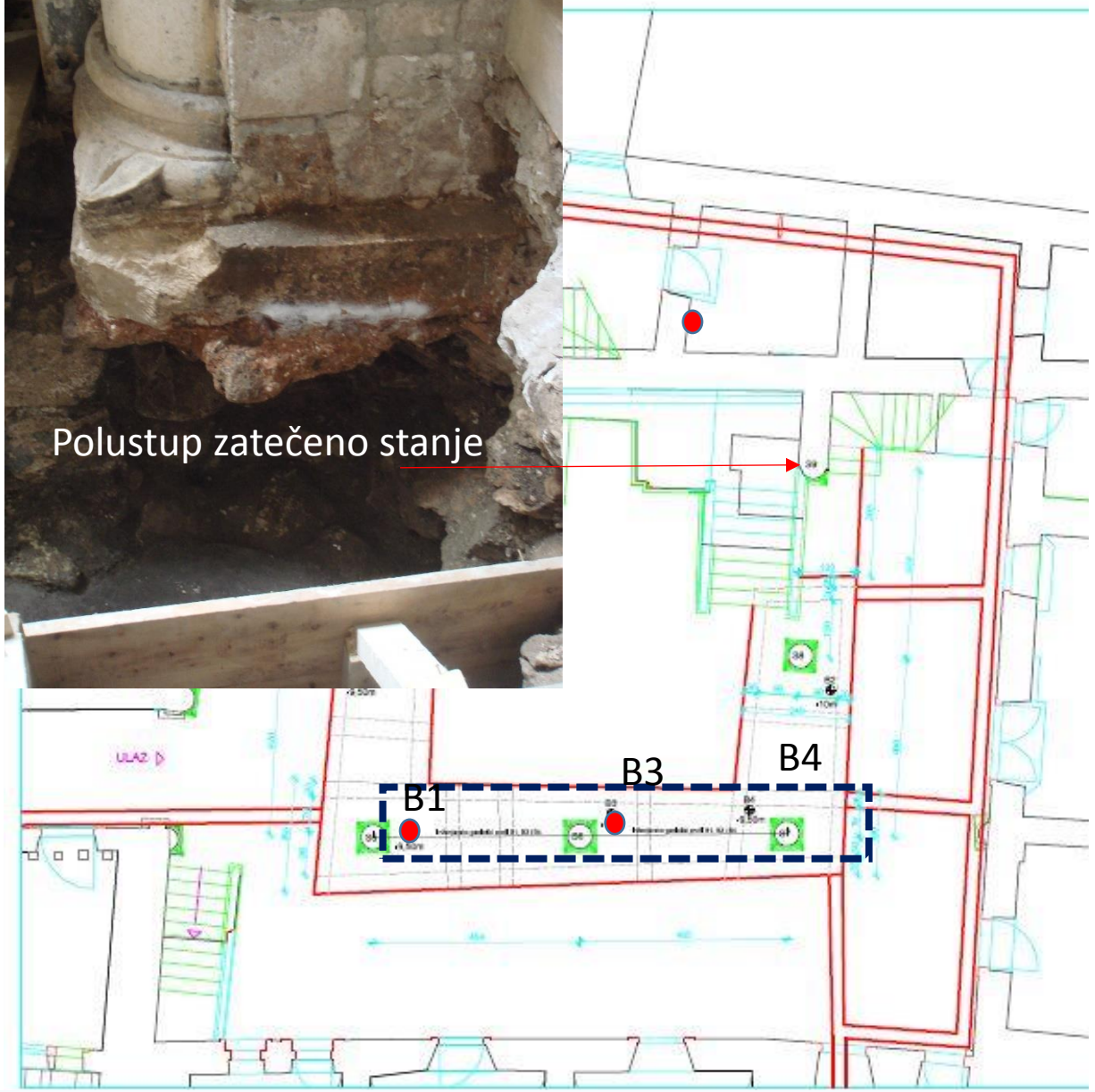

**GEOL PROFIL PREMA ISTRAŽNOJ SONDI S1 IZ 1974. PODUDARA SE SA ISTRAŽNIM BUŠ IZ 2016.**

**GEOLOŠKA ISTRAŽIVANJA IZ 1974 GOD**



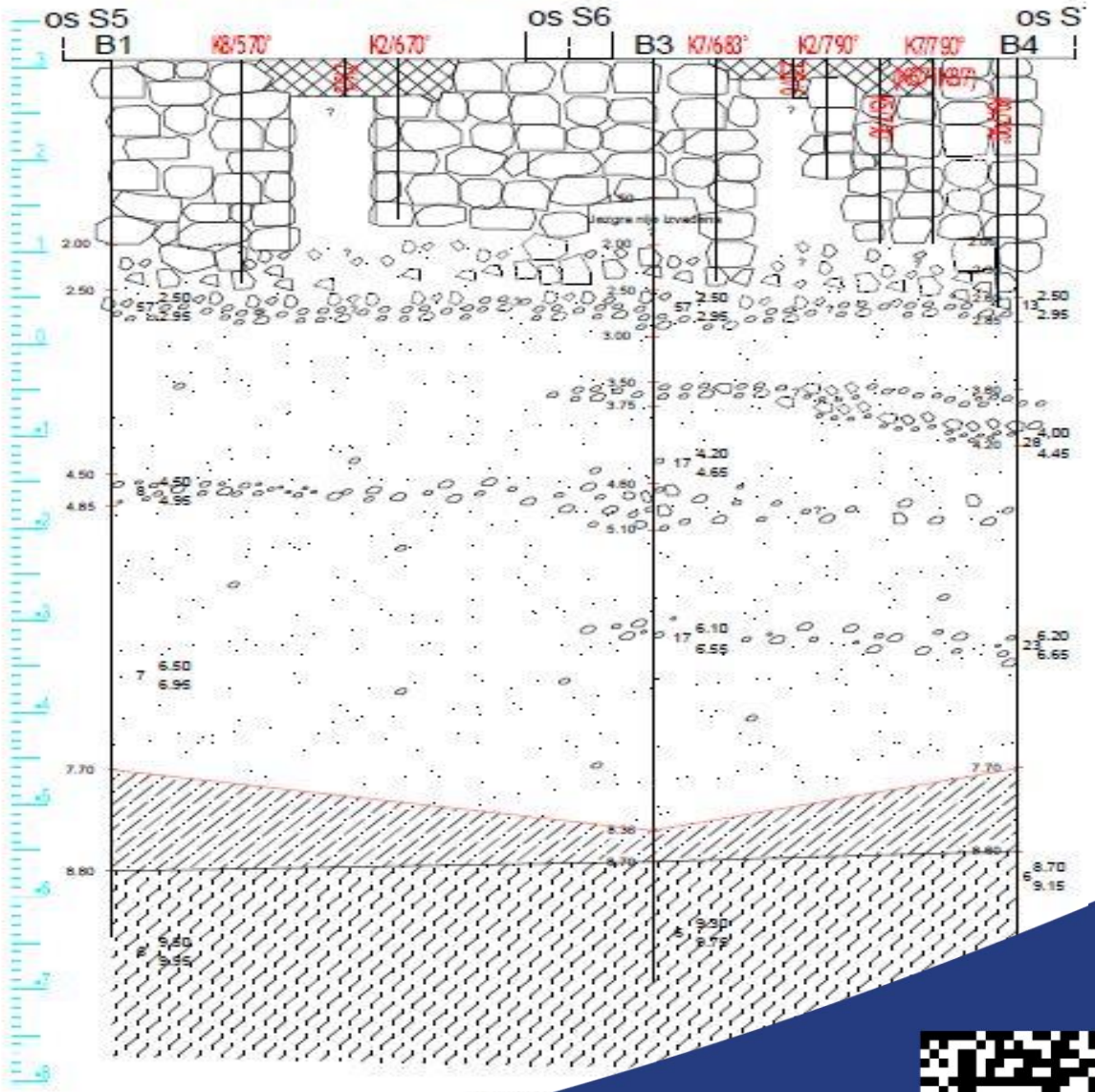




www.spegra.hr

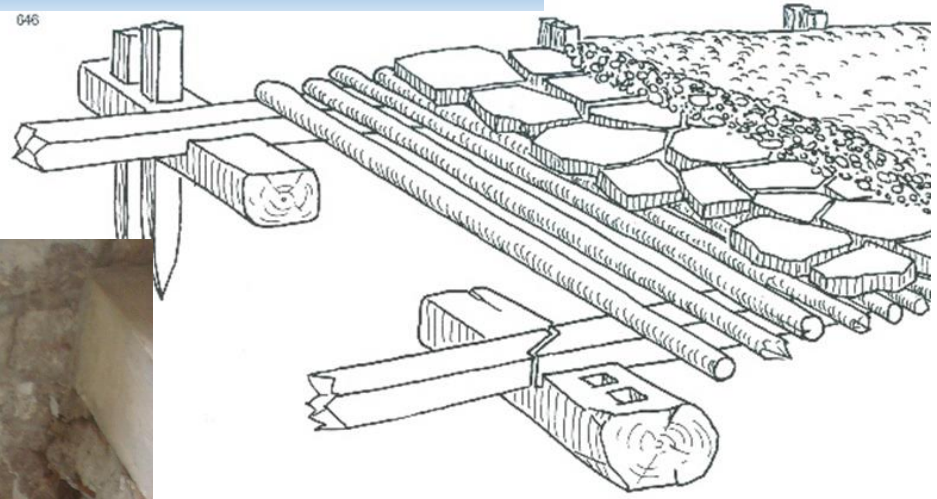

## ISTRAŽNE BUŠOTINE U TEMELJIMA STUPOVA IZ 2016.

## INŽENJERSKO GEOLOŠKI PROFIL B1-B2-B3



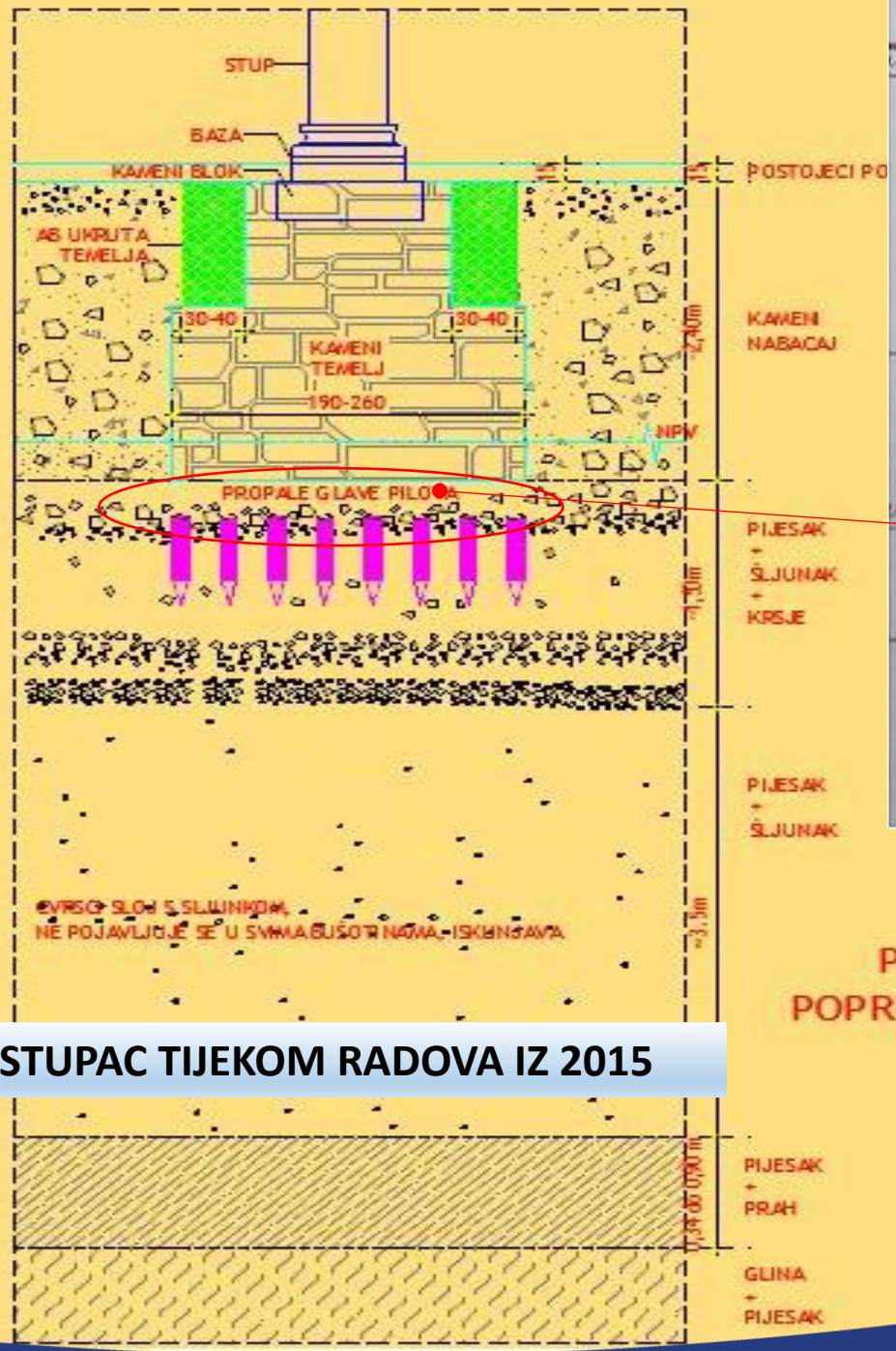

www.spegra.hr

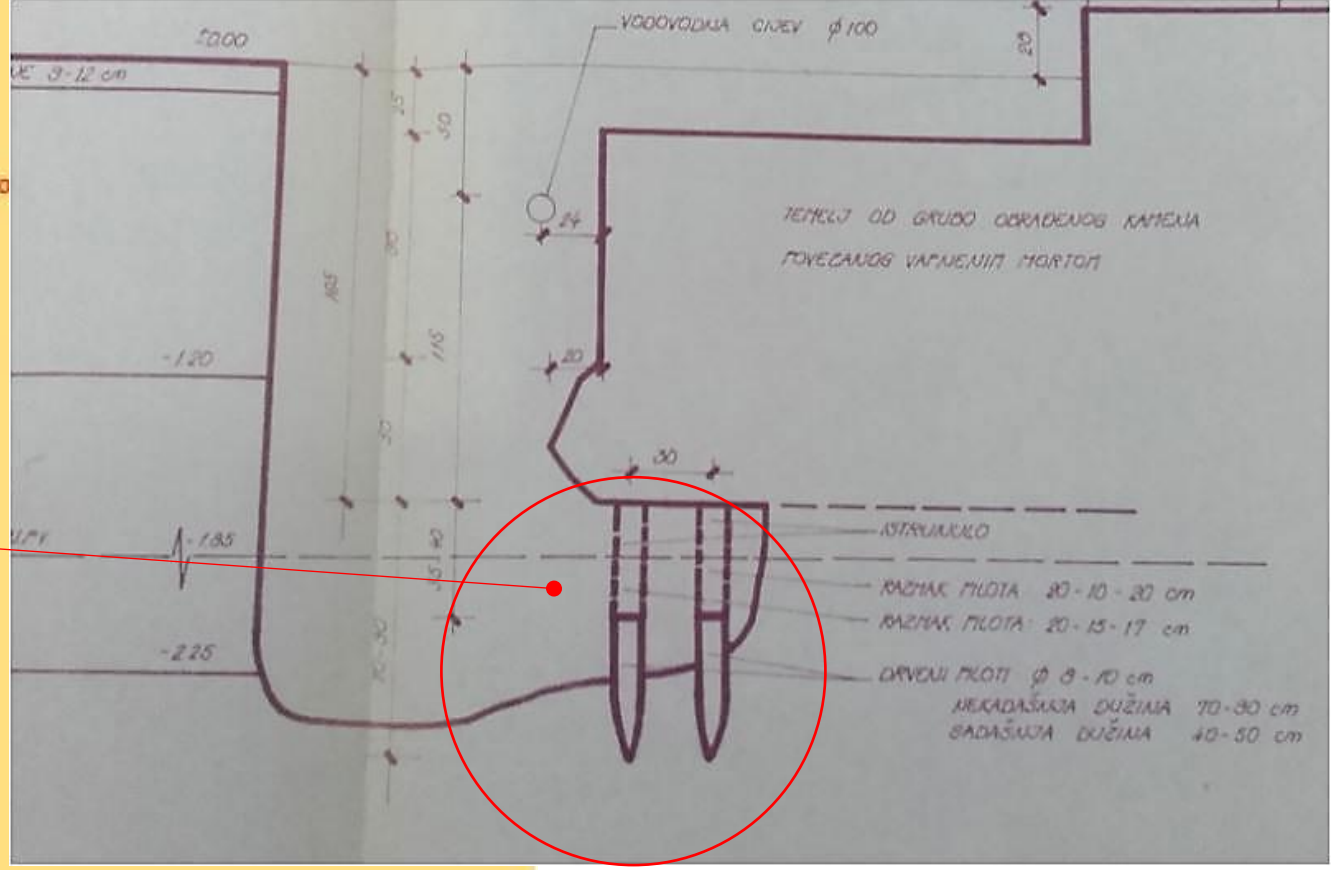
# GEOMEHANIČKA SONDA 1974.

Pretpostavljeni način prenosa opterećenja na pilote

**DRVENI PILOTI PROMJERA 8-10 CM**
**RAZMAK PILOTA 20-10-20 CM**
**NEKADAŠNJA DUŽINA 70-90 CM,**
**SAČUVANI U VISINI 40-50 CM.**



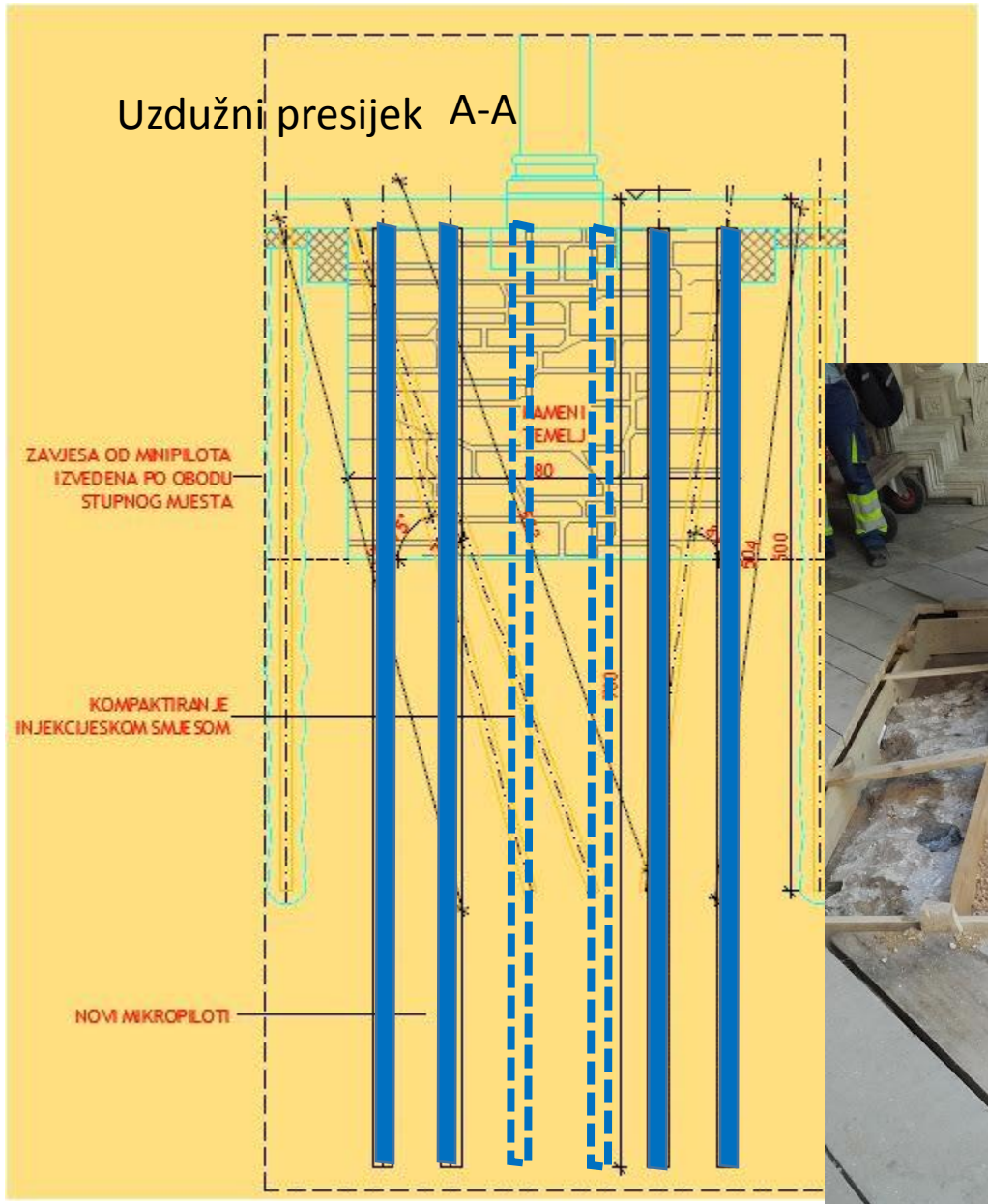

POSTOJEĆE STANJE
POPREČNI PRESJEK TEMELJA

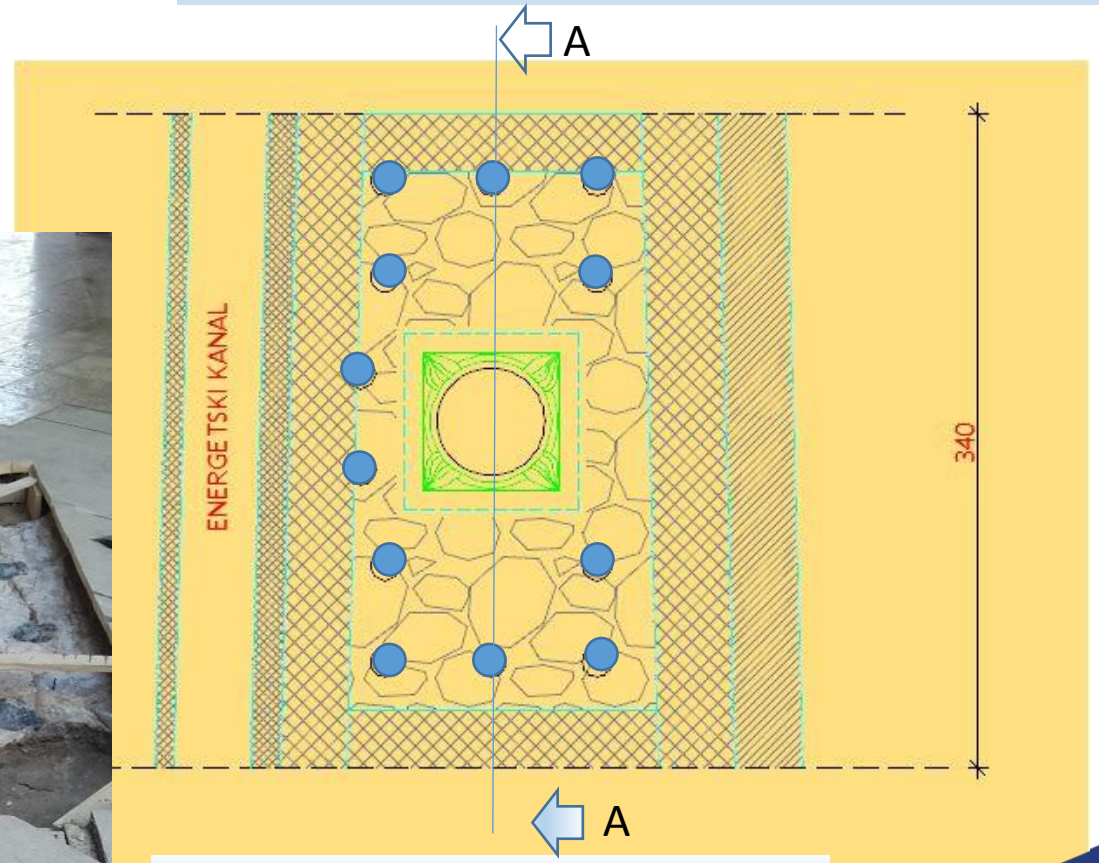
**GEOLOŠKI STUPAC TIJEKOM RADOVA IZ 2015**

**SONDA IZ 1974 GODINE**

www.spegra.hr

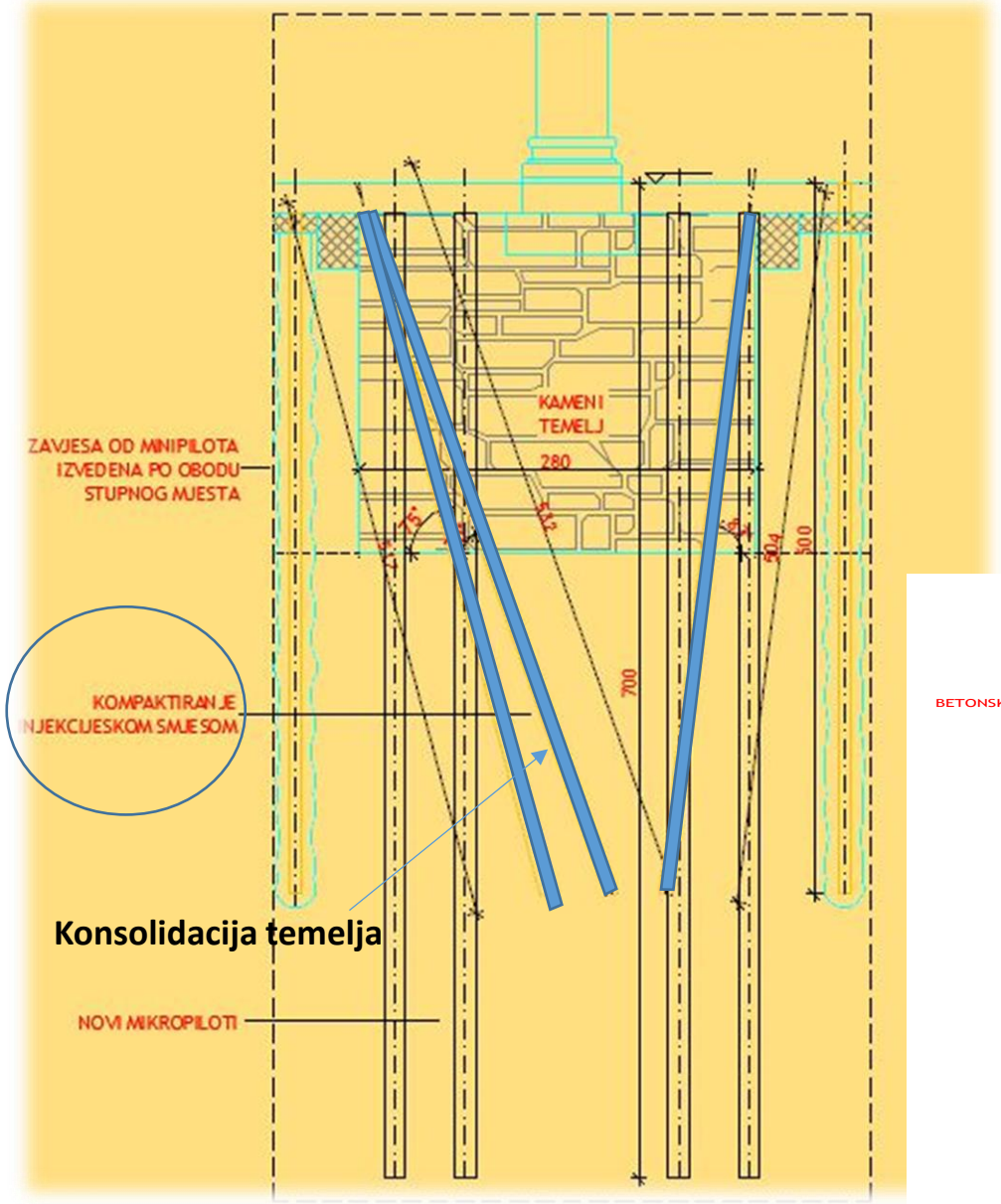
## MODIFICIRANO PROJEKTNO RJEŠENJE IZ 2016. S BETONSKIM PILOTIMA



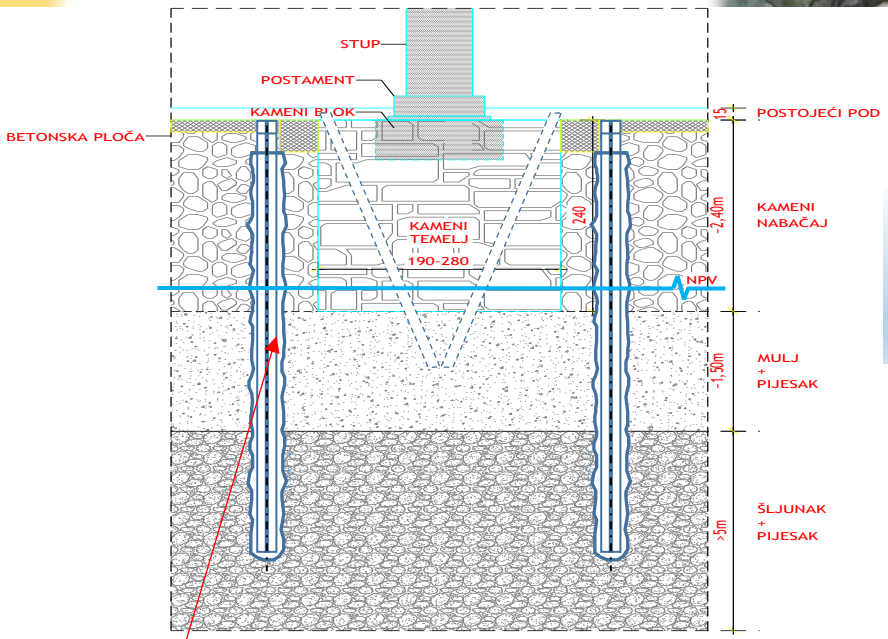

**NOVI MIKROPILOTI DIA 200MM**

www.spegra.hr



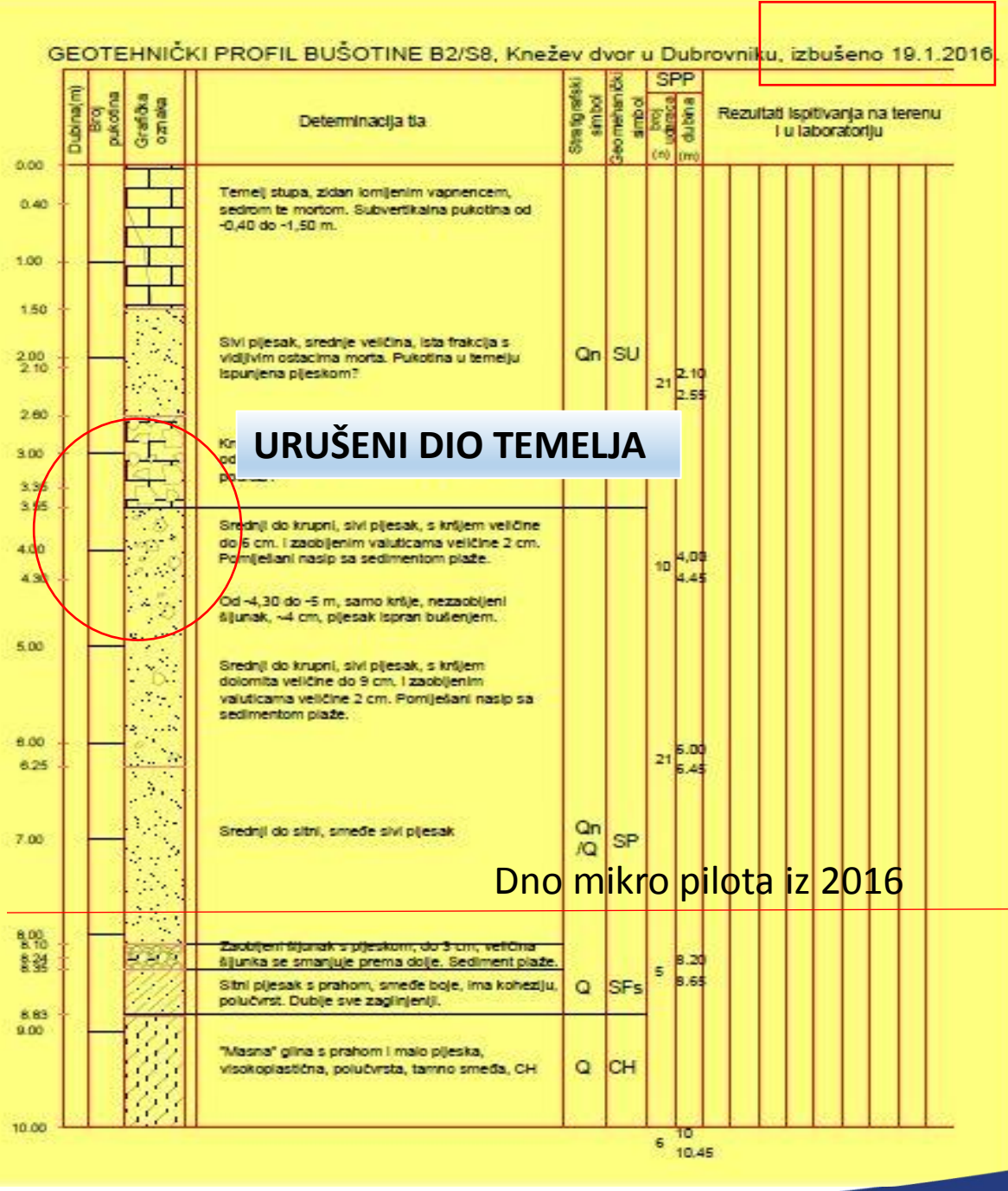

## VIDEO ENDOSKOPSKI NALAZ PRIJE INJEKTIRANJA TEMELJA

## VIDEO ENDOSKOPSKI NALAZ NAKON INJEKTIRANJA TEMELJA

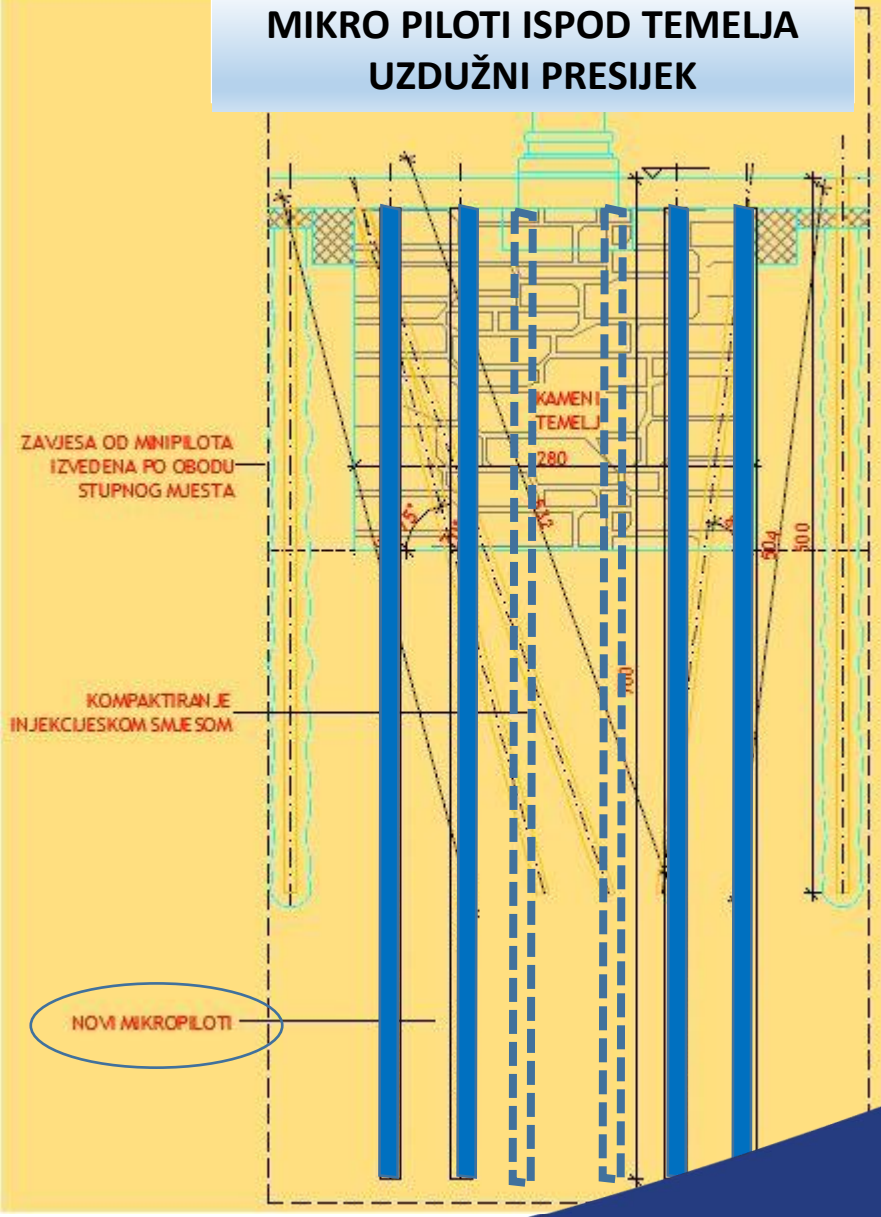



## III. FAZA SANACIJE-PRETHODNO IZVEDENA ZAVJESA OKO TEMELJNE STOPE

## INJEKCIJSKA ZAVJESA




## MIKRO PILOTI ISPOD TEMELJA UZDUŽNI PRESIJEK




www.spegra.hr

## BUŠAĆA GARNITURA LUMESA ZA IZVOĐENJE BETONSKIH MIKROPILOTA


## IZVOĐENJE TEMELJNIH PILOTA

www.spegra.hr

www.spegra.hr



# SVETI IGNJACIJE, DUBROVNIK

## PODUPIRANJE KAPITELA

www.spegra.hr

spegra

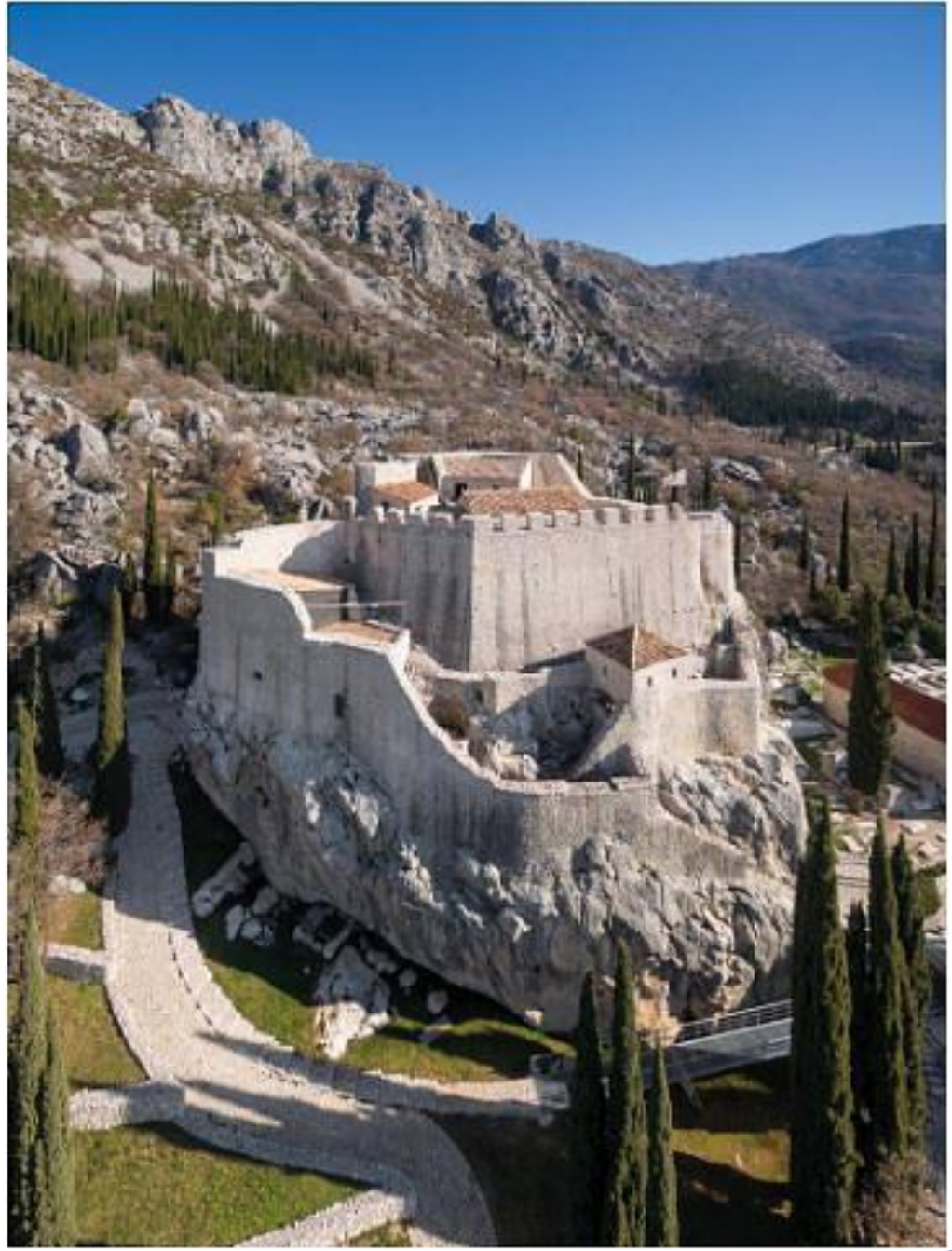




www.spegra.hr

spegra


www.spegra.hr

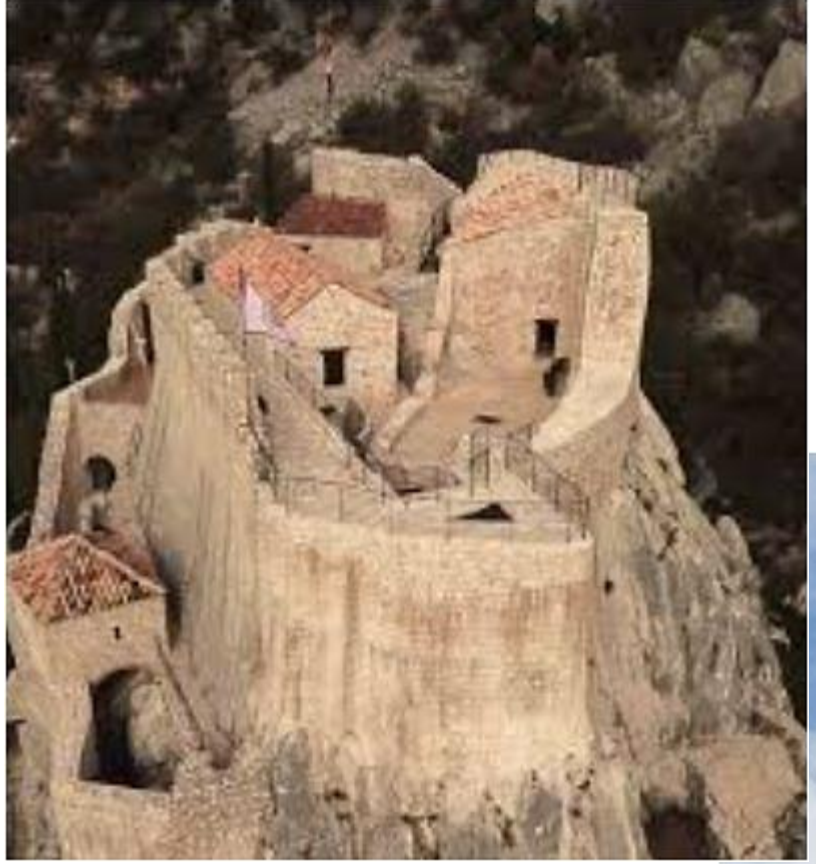


spegra

# SOKOL KULA

## OJAČANJE I STABILIZACIJA KAMENIH ZIDOVA

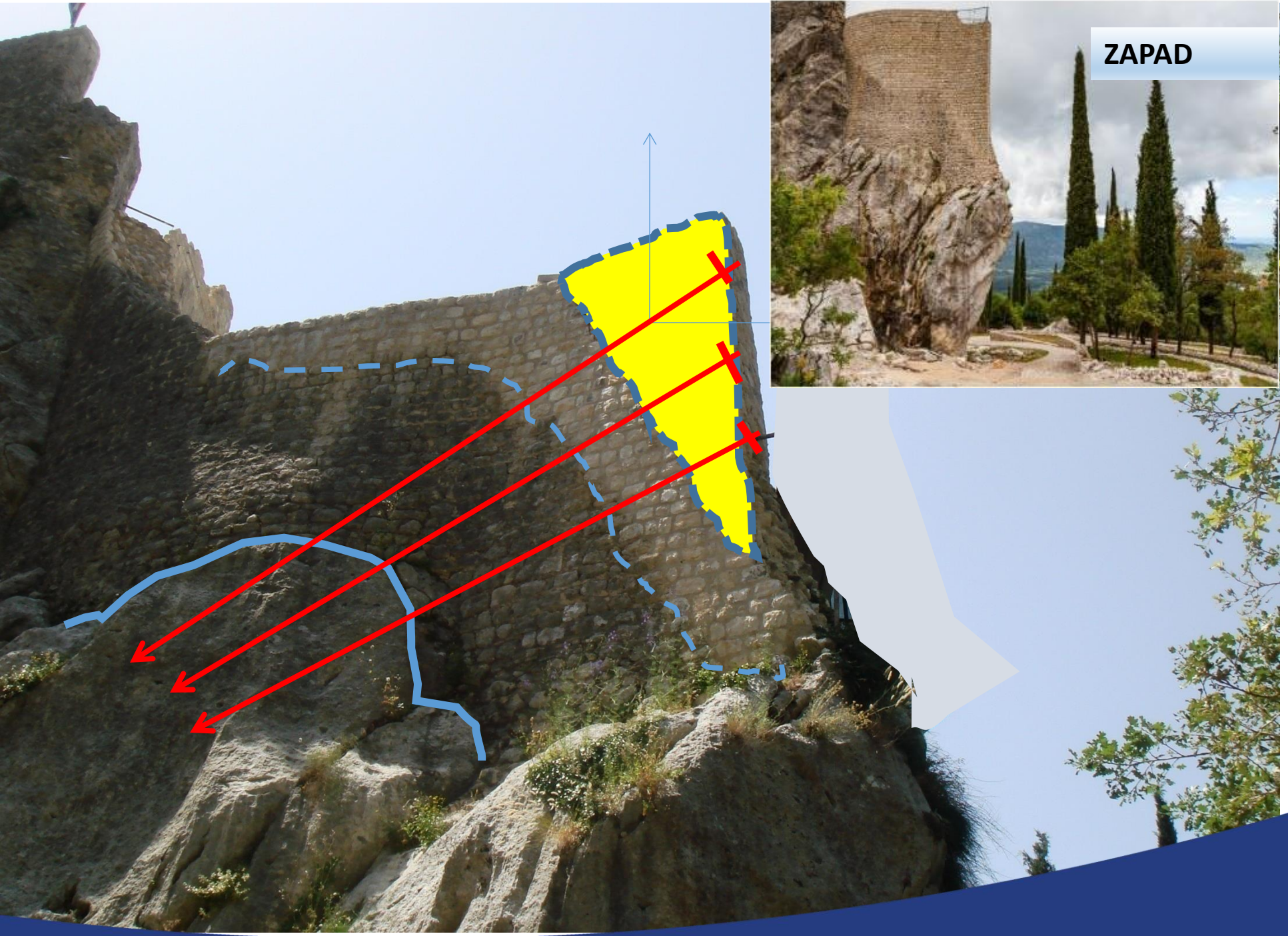
www.spegra.hr



Ova iznimna građevina prvi se put spominje 1391. godine u Dubrovačkom arhivu, no položaj tvrđave sugerira postojanje utvrde na istom mjestu još iz vremena Ilira, Grka i Rimljana o čemu svjedoče ostaci keramike i rimske cigle u zidinama tvrđave. Konačan oblik Sokol Kula dobiva u vrijeme slavne Dubrovačke Republike 1419. godine nakon kupnje istočnog dijela Konavala. Tvrđava je osim svoje obrambene funkcije služila i za pohranu municije i oružja te za zalihe žita i vina u slučaju iznimnih ratnih okolnosti. Tvrđava Sokol imala je dva spremnika za vodu, zgradu municije, skladište vina i hrane te stan kaštelana, koji je upravljao ovom strateški važnom utvrdom, zgrade za stražare i smještaj za žene i djecu iz obližnjih sela u slučaju opasnosti.

spegra

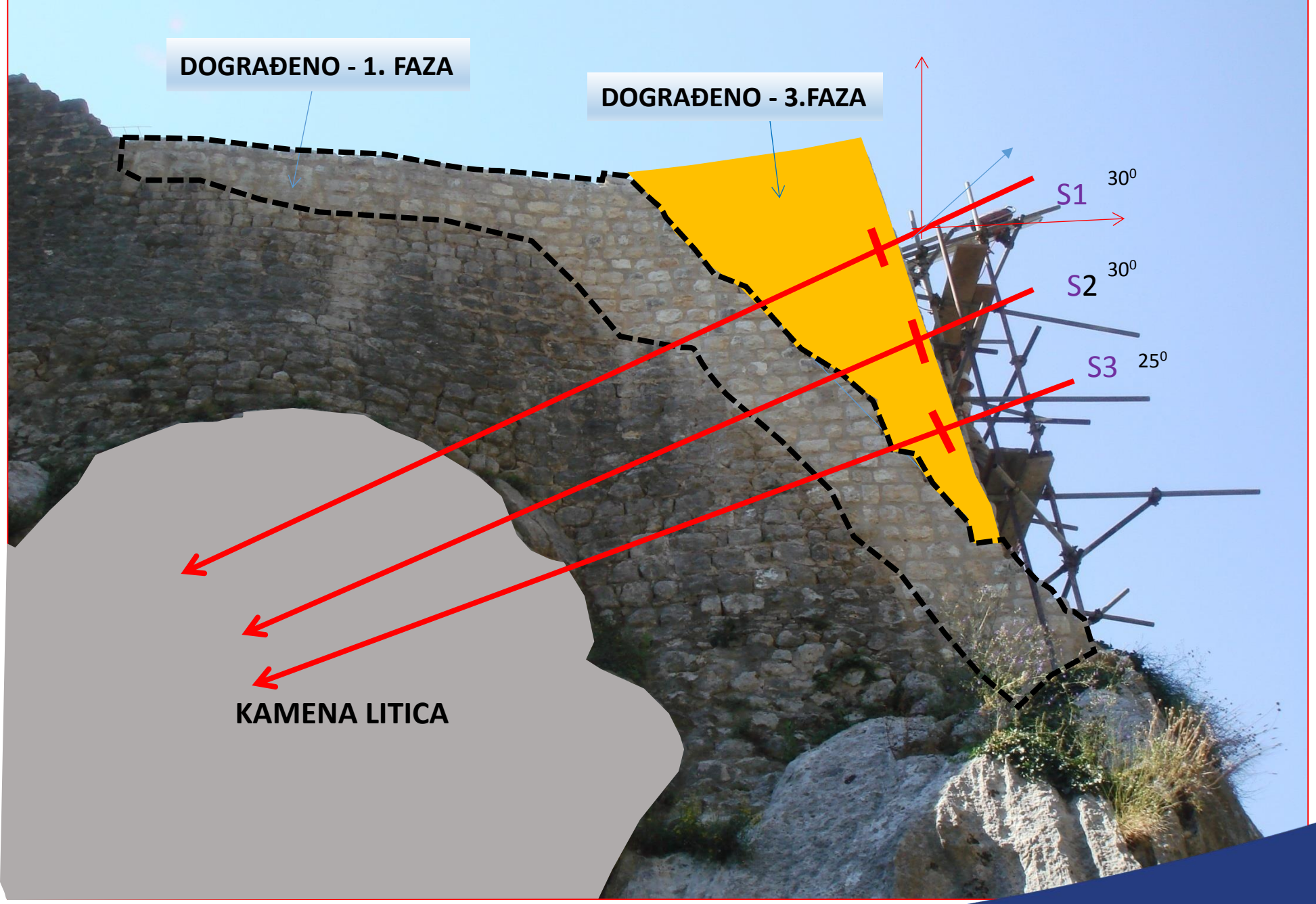
www.spegra.hr






spegra

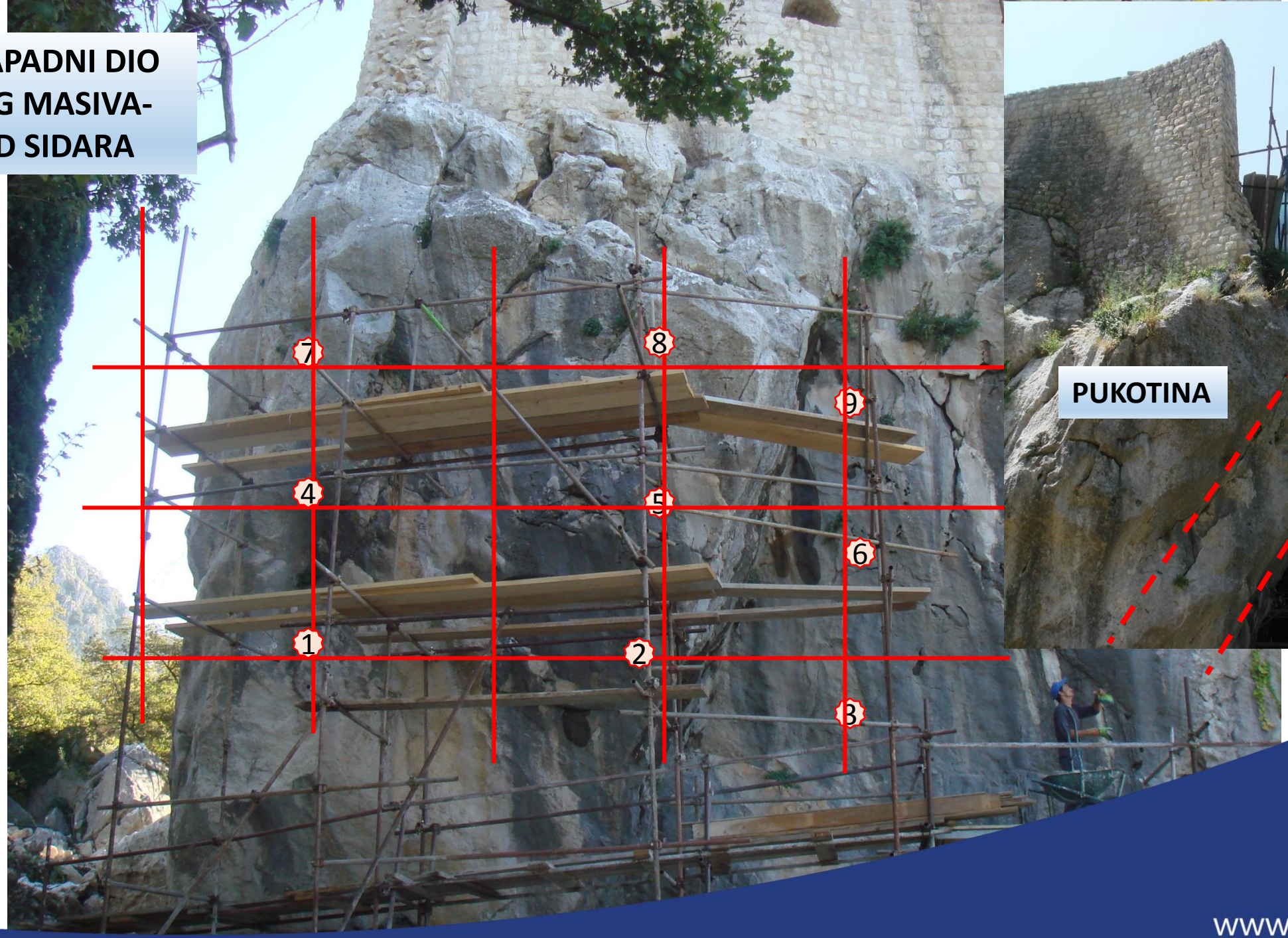
www.spegra.hr

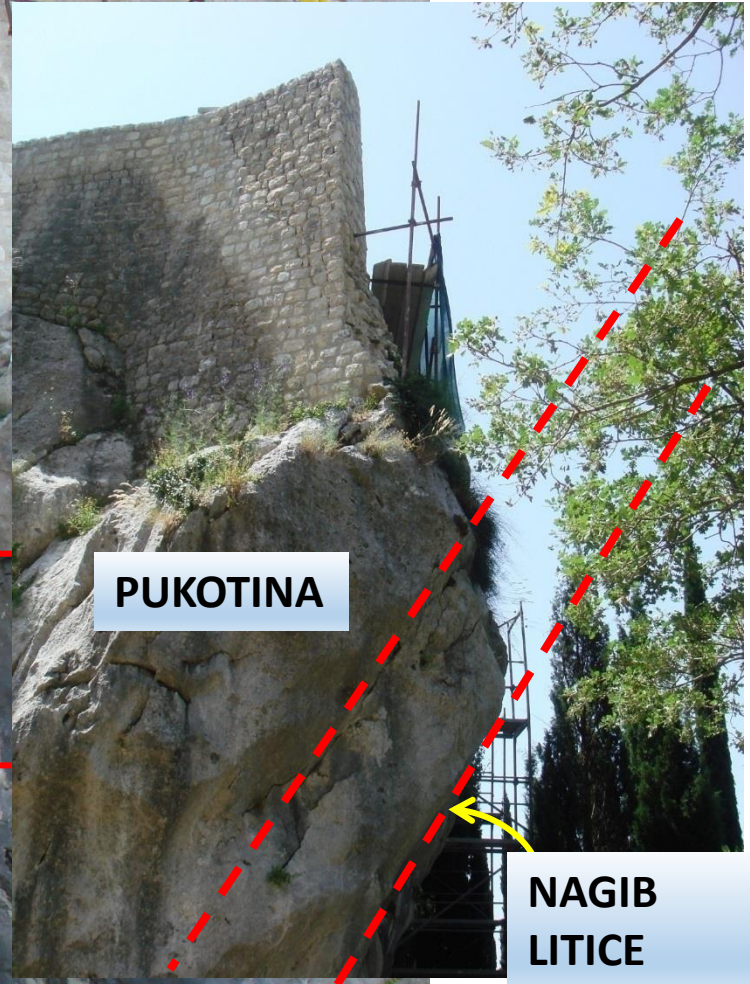



spegra

www.spegra.hr

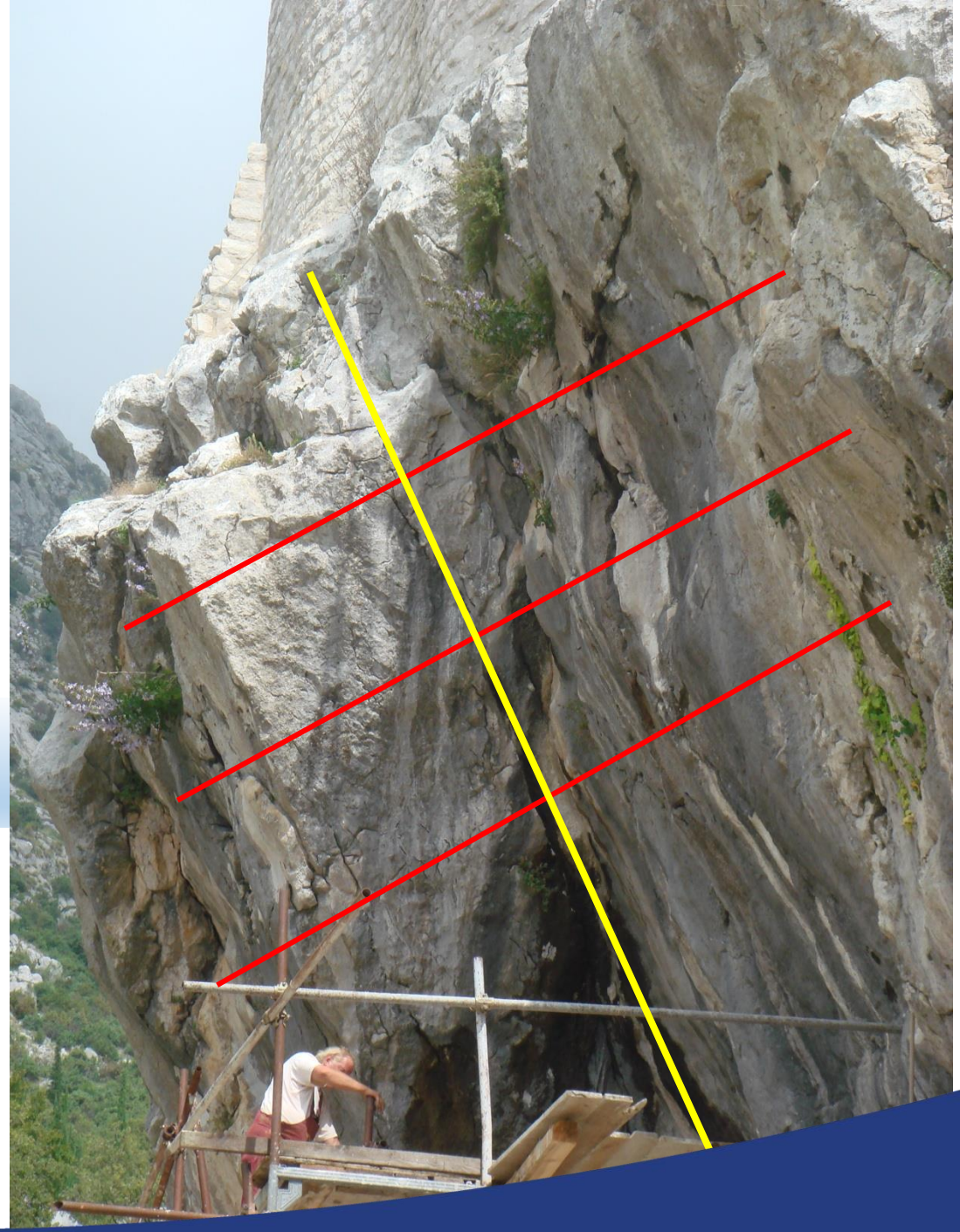
# SJEVERO ZAPADNI DIO STIJENSKOG MASIVA- RASPORED SIDARA

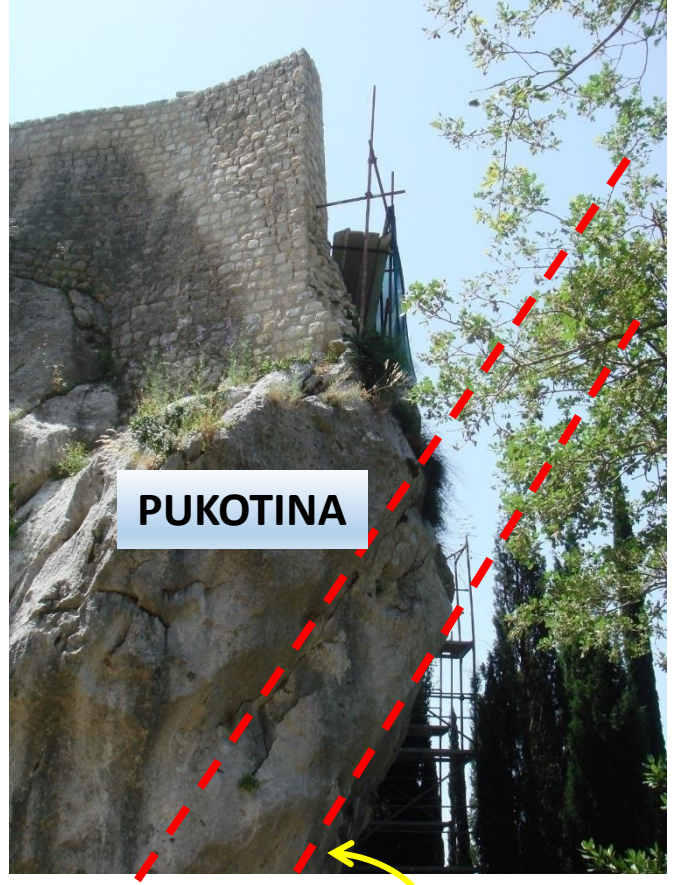


spegra

**SJEV. ZAPAD DIO STIJENSKOG MASIVA - POGLED ODOZDO**

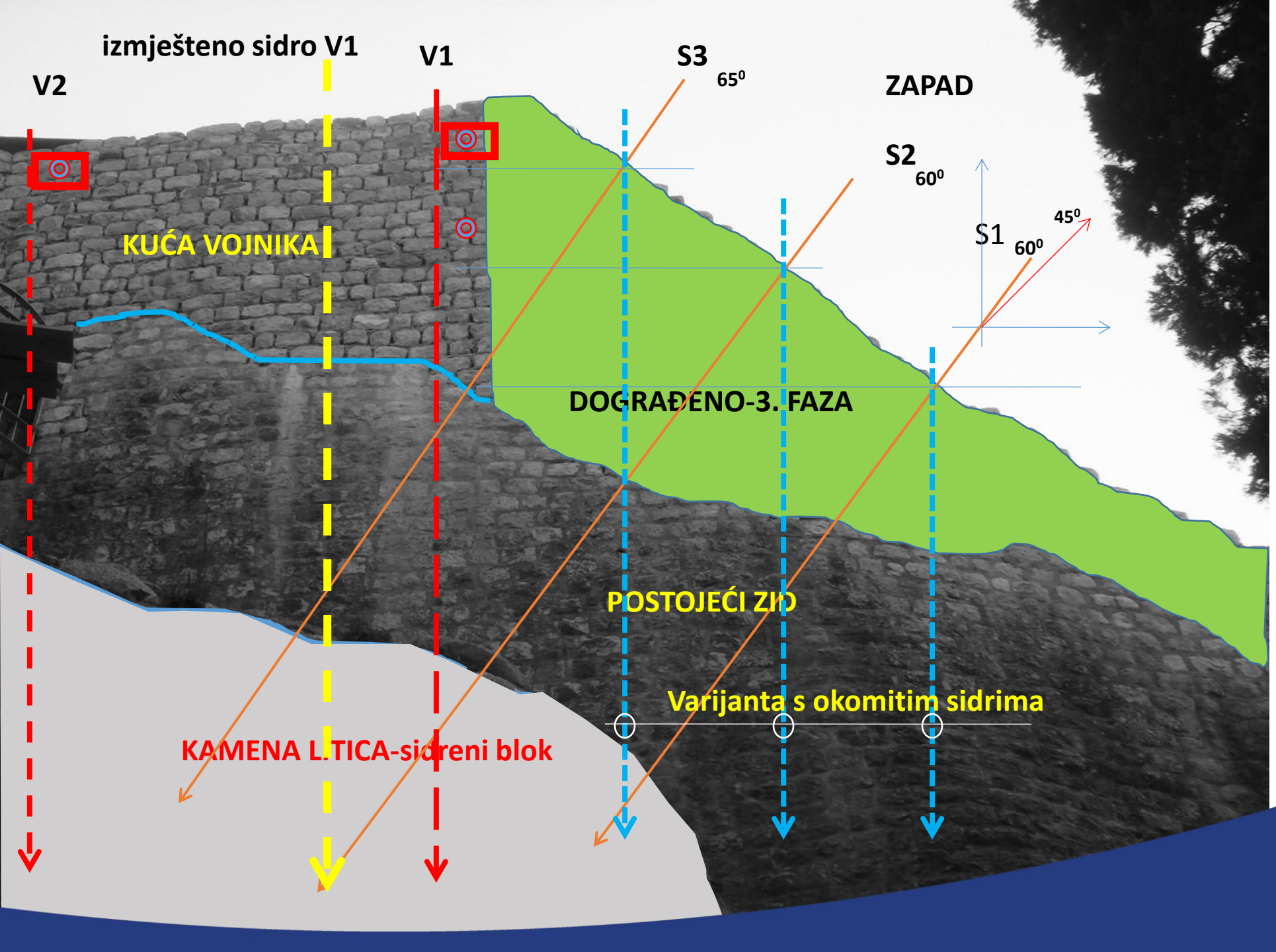




Istražna bušotina

ČEP-TAŠEL

**IZVEDENO STANJE**
**ZAVRŠENA UGRADNJA SIDARA**



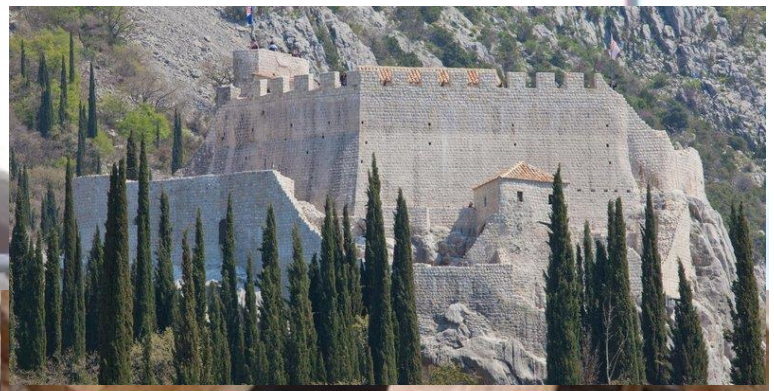

spegra

www.spegra.hr

spegra

www.spegra.hr





spegra

www.spegra.hr





spegra

www.spegra.hr

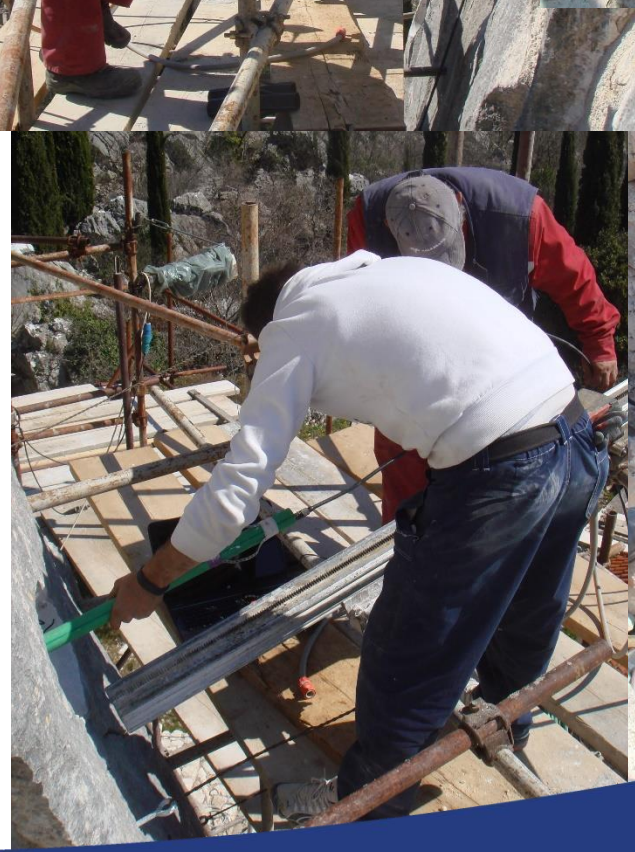
spegra

www.spegra.hr

spegra

www.spegra.hr

spegra



www.spegra.hr

spegra

www.spegra.hr

spegra

www.spegra.hr

spegra

# PALAČA LEŠIĆ, KORČULA

## KONSOLIDACIJA TEMELJA, MIKRO PILOTI

www.spegra.hr









www.spegra.hr



www.spegra.hr




www.spegra.hr

# KULA SVI SVETI KORČULA

## KONSOLIDACIJA TEMELJA INJEKTIRANJEM

www.spegra.hr





www.spegra.hr





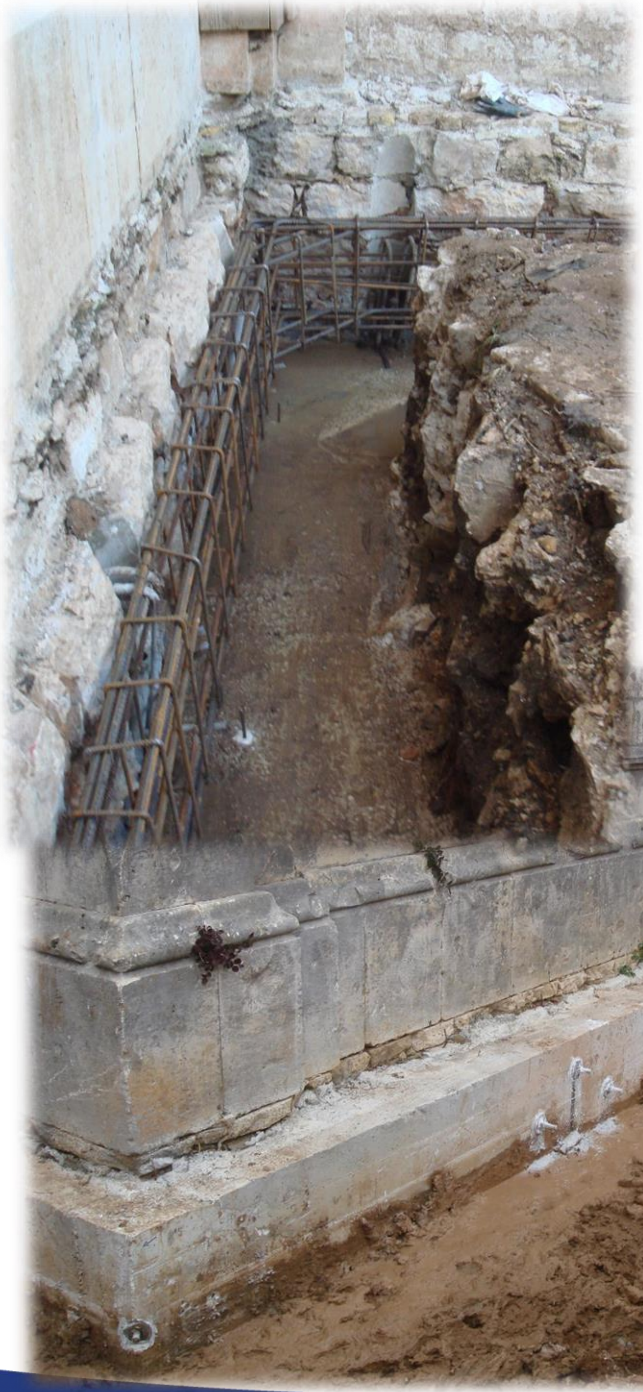
www.spegra.hr

# SVETI VLAHO, STON

## KONSOLIDACIJA TEMELJA
## MIKRO PILOTI

www.spegra.hr

www.spegra.hr



www.spegra.hr


www.spegra.hr



www.spegra.hr

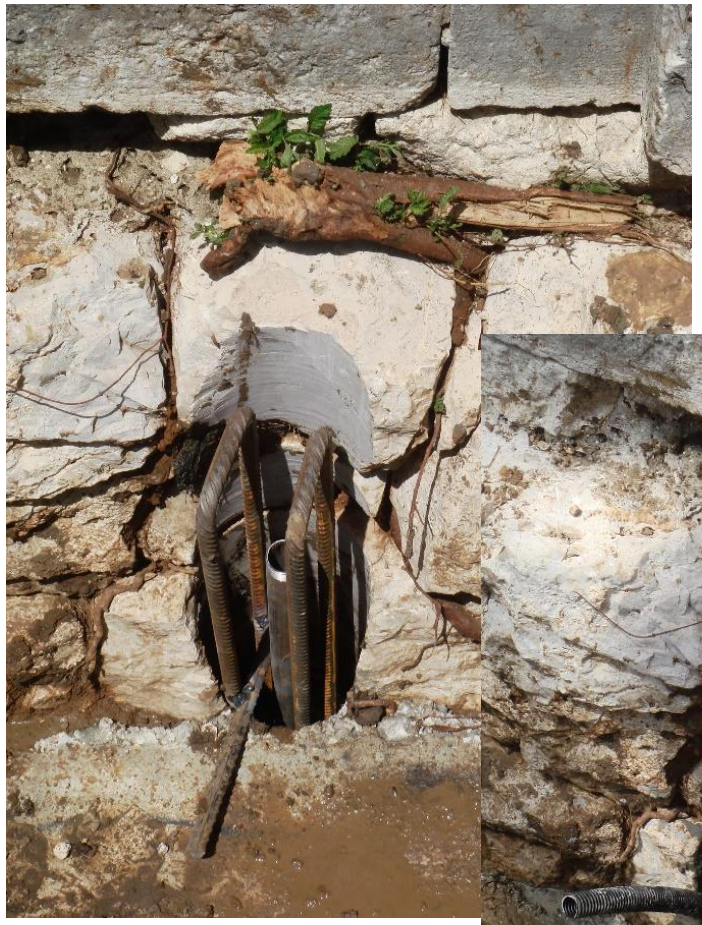


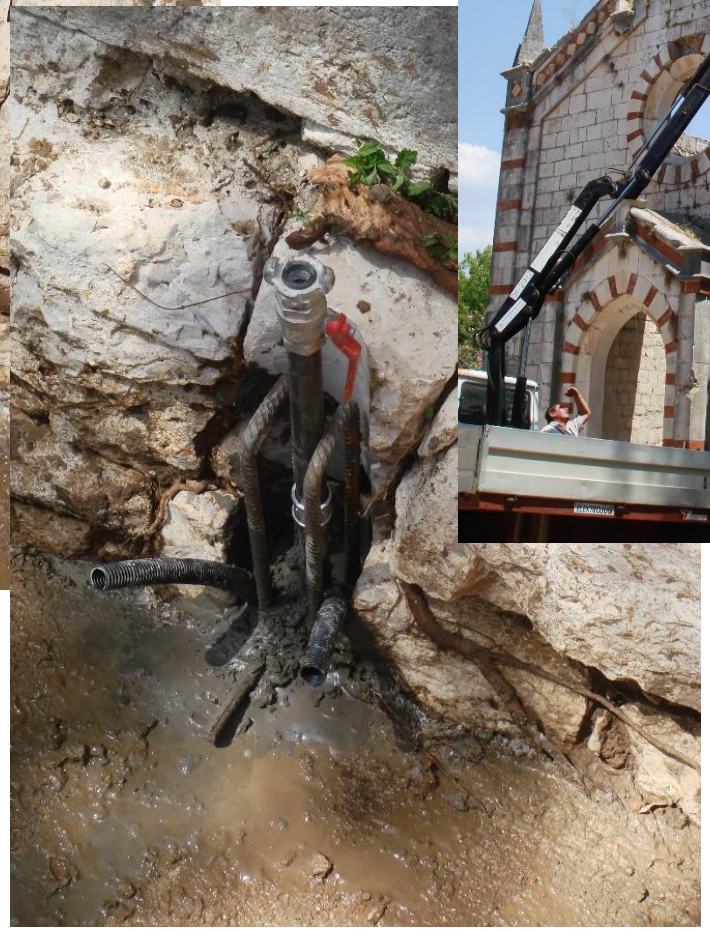




www.spegra.hr

www.spegra.hr

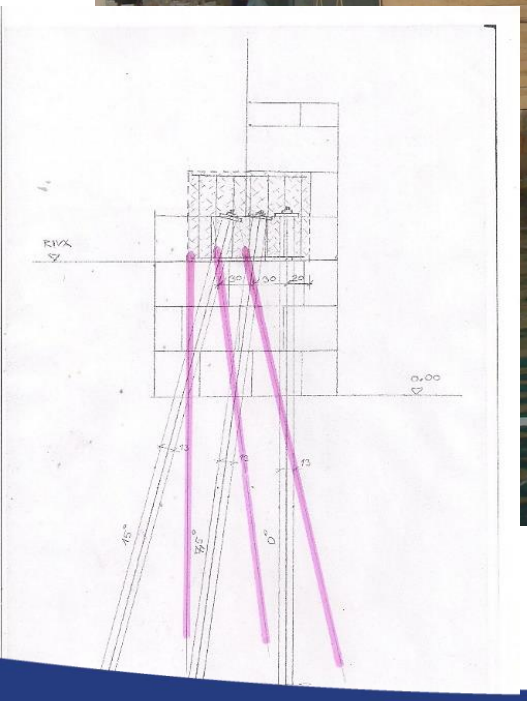


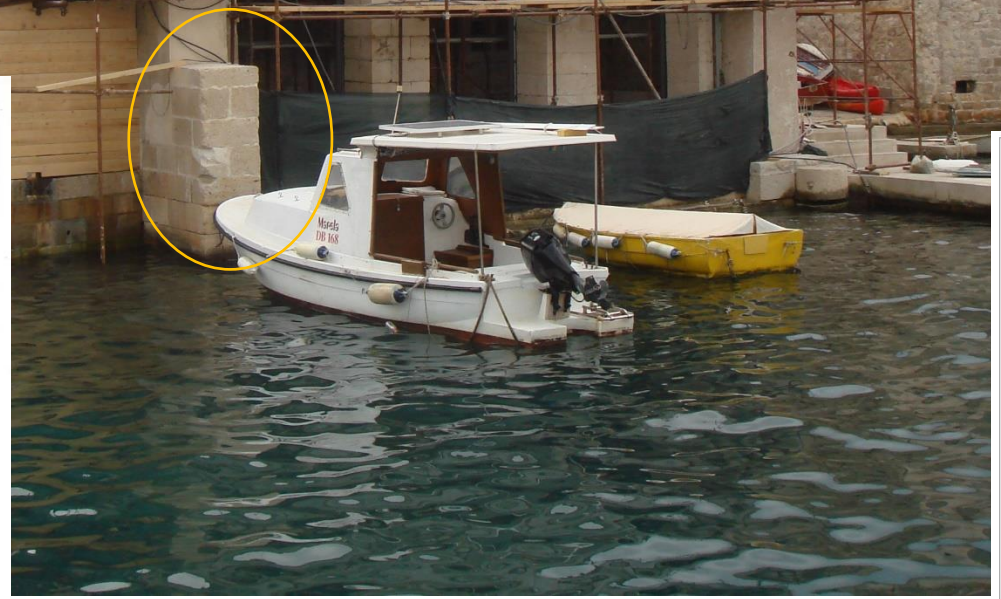


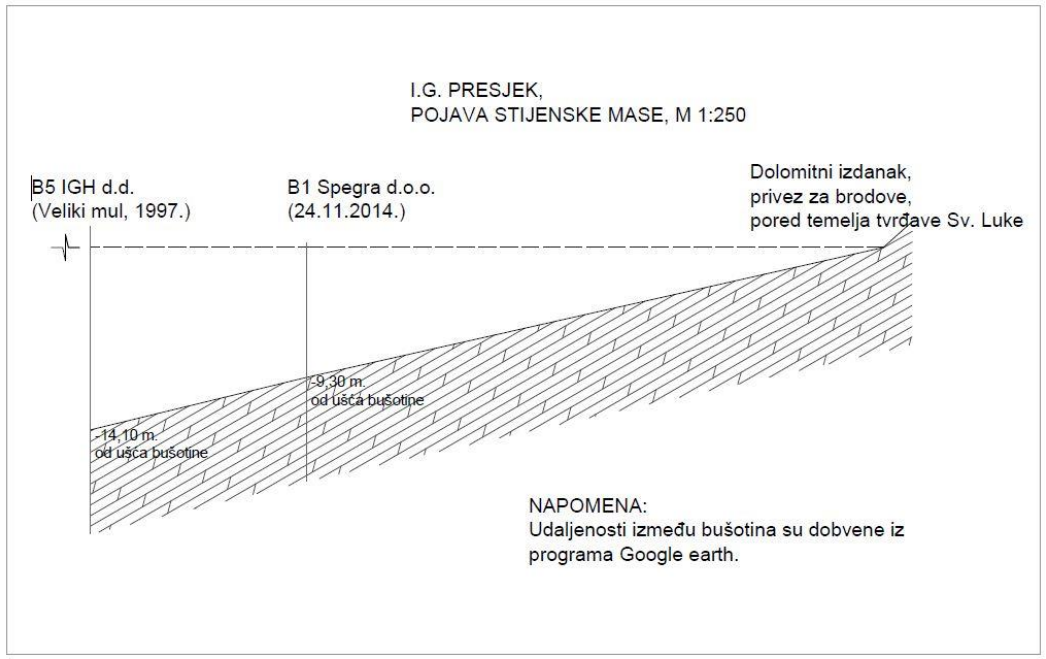
www.spegra.hr

# RIBARNICA, POVJESNA JEZGRA DUBROVNIK

## KONSOLIDACIJA TEMELJA MIKRO PILOTI

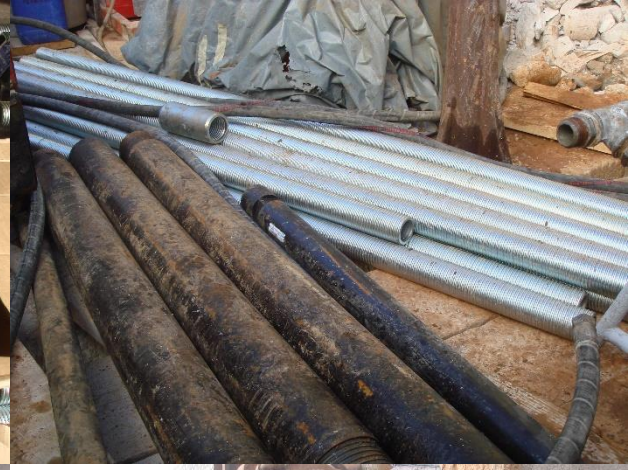




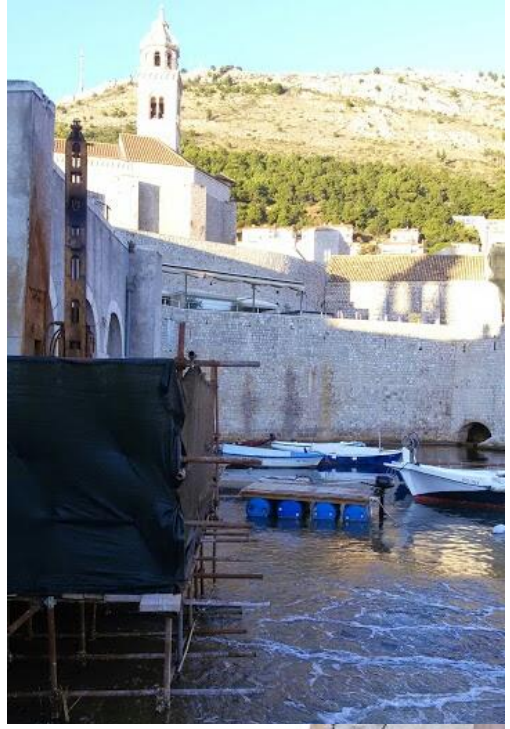



SILENT


0-025/43 UR. BROJ:2117/01-13-10-13
inca 2010. god.
nju važenja od 26. studenoga 2012. god.
adenja 06. studenoga 2014. god
građevina je upisana kao nepokretno kulturno dobro.

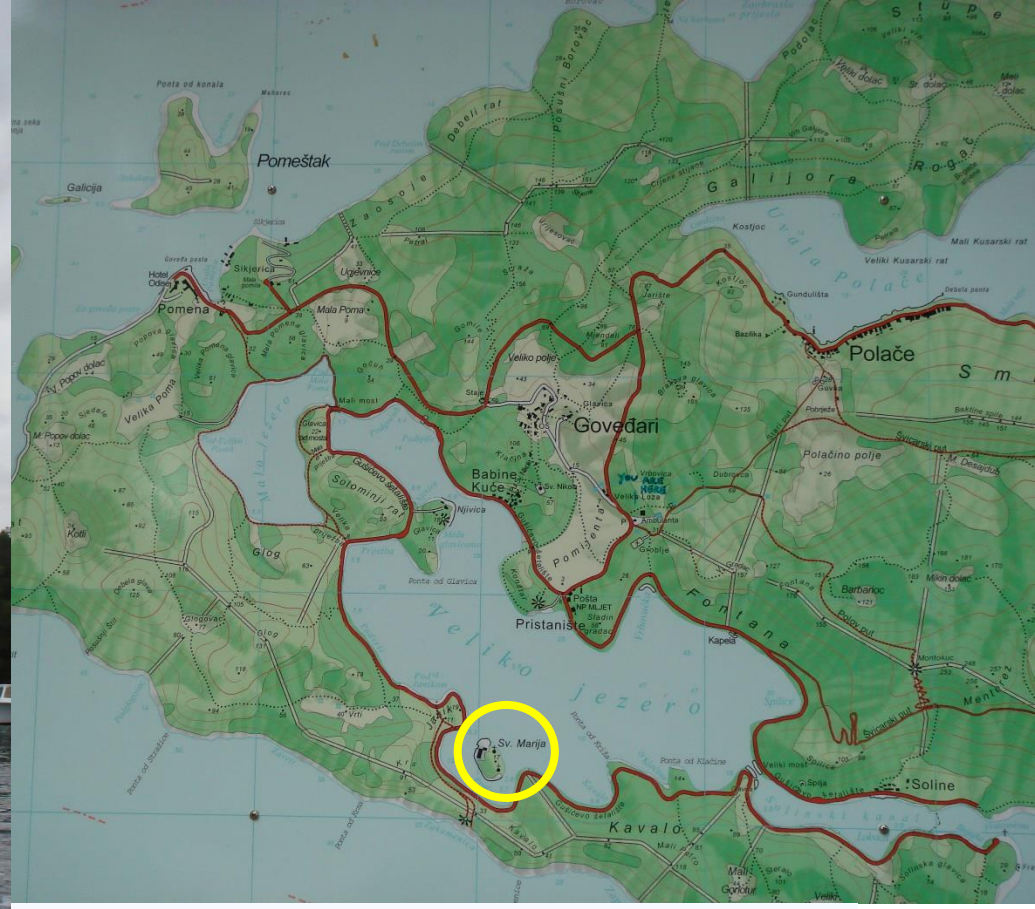








www.spegra.hr

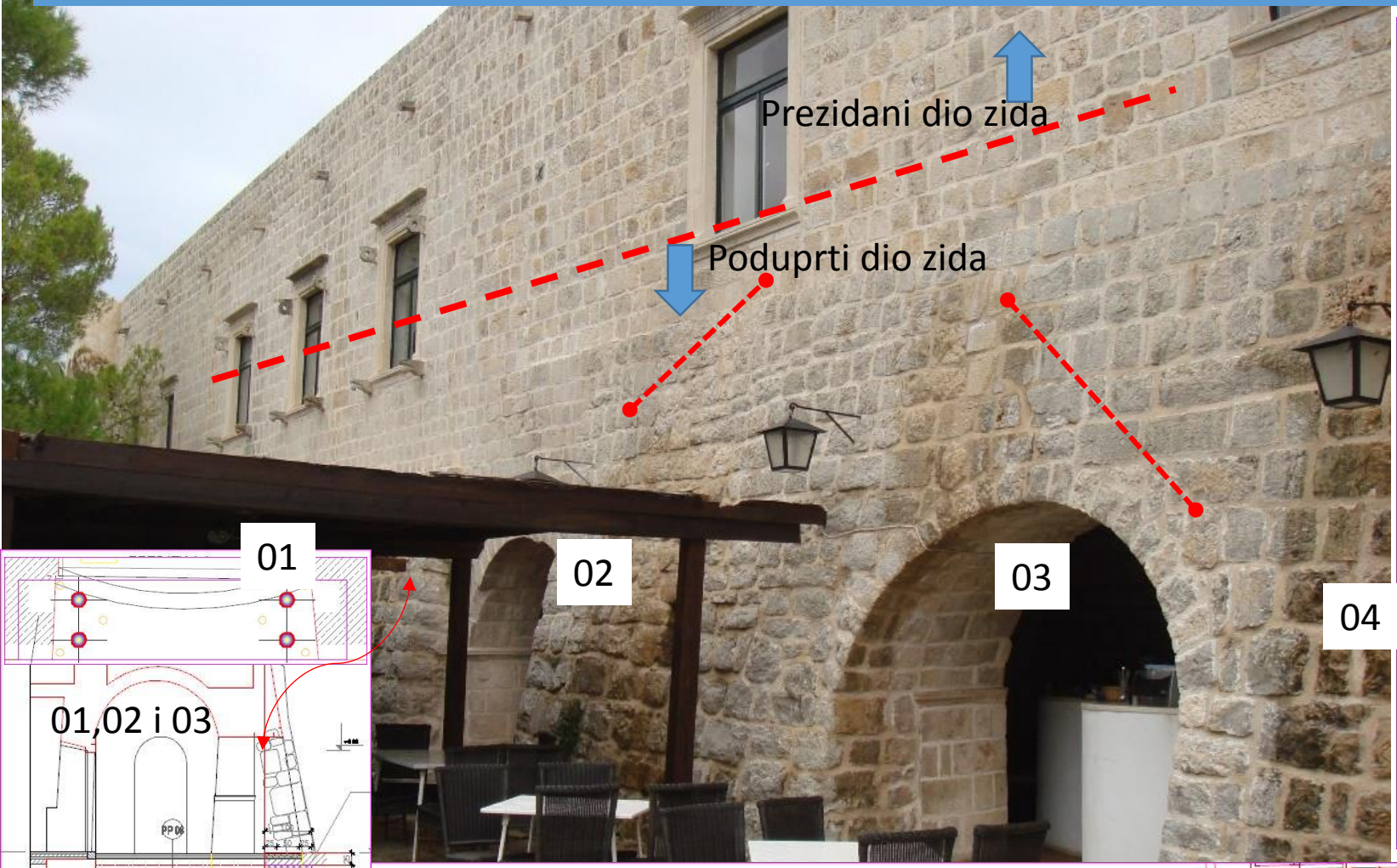

0-025/43 UR. BROJ:2117/01-13-10-15
inca 2010. god.
nju važenja od 26. studenoga 2012. god.
ađenja 06. studenoga 2014. god
: građevina je upisana kao nepokretno kulturno dobro.



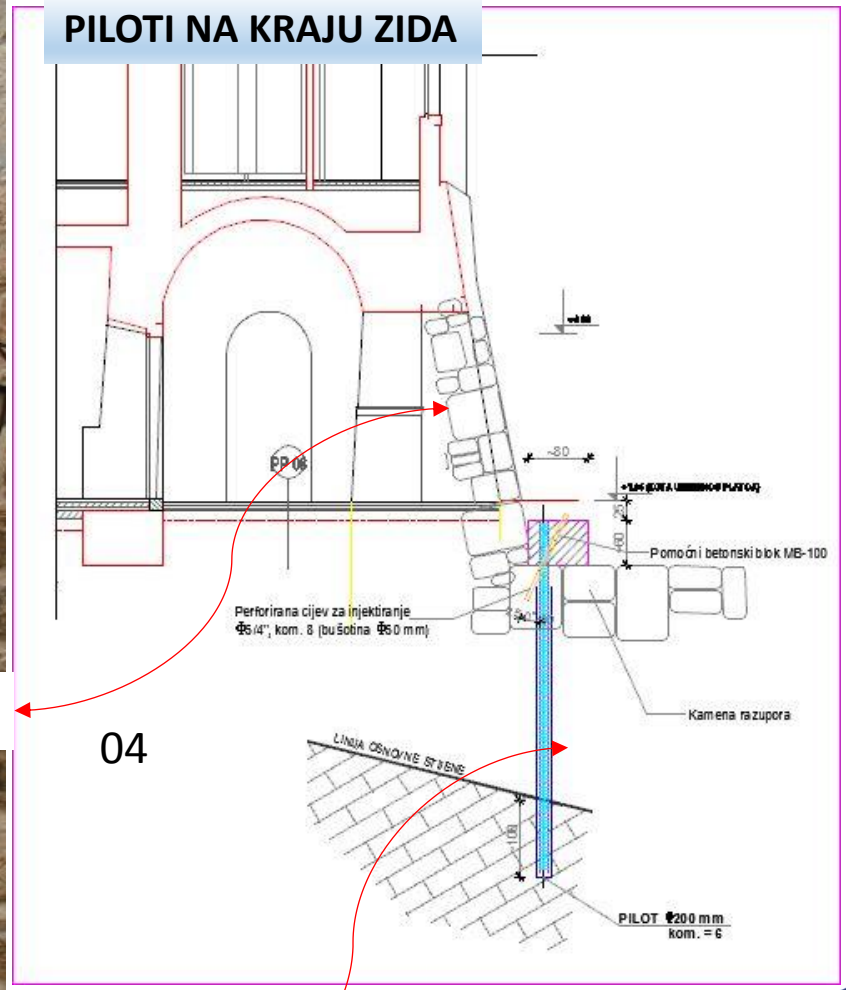

# SVETA MARIJA, MLJET
# SANACIJA TEMELJA, MIKRO PILOTI

www.spegra.hr

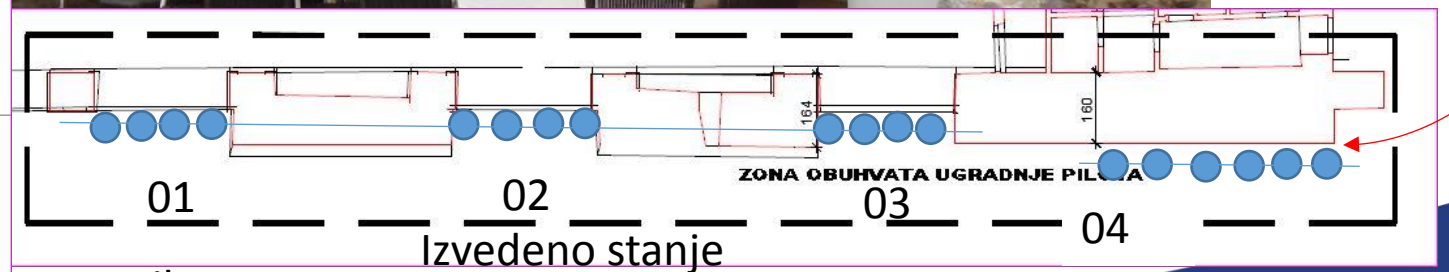
# DETALJI KOD IZVOĐENJA MIKRO PILOTA




## PILOTI NA KRAJU ZIDA



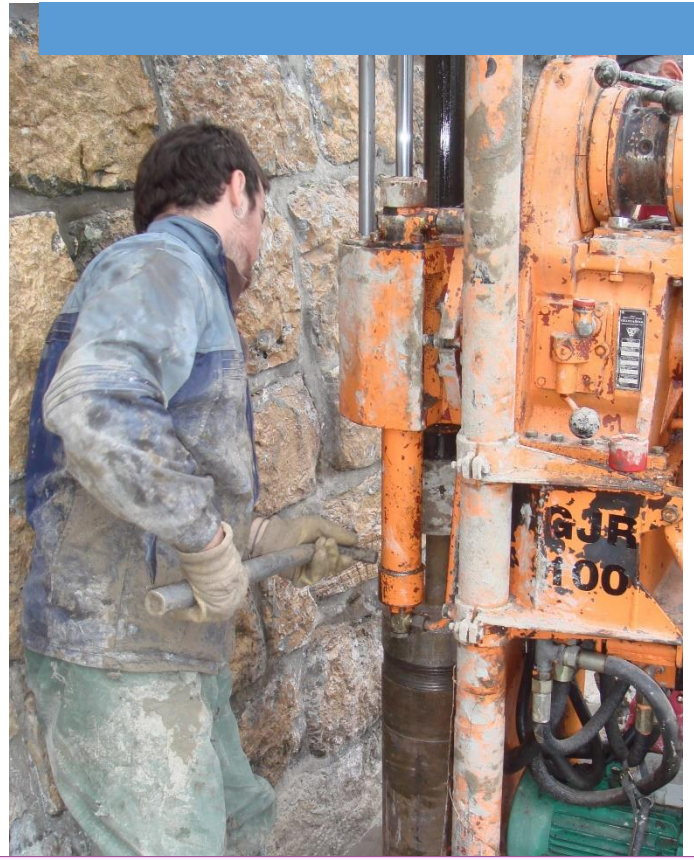

## PILOTI ISPOD LUKOVA

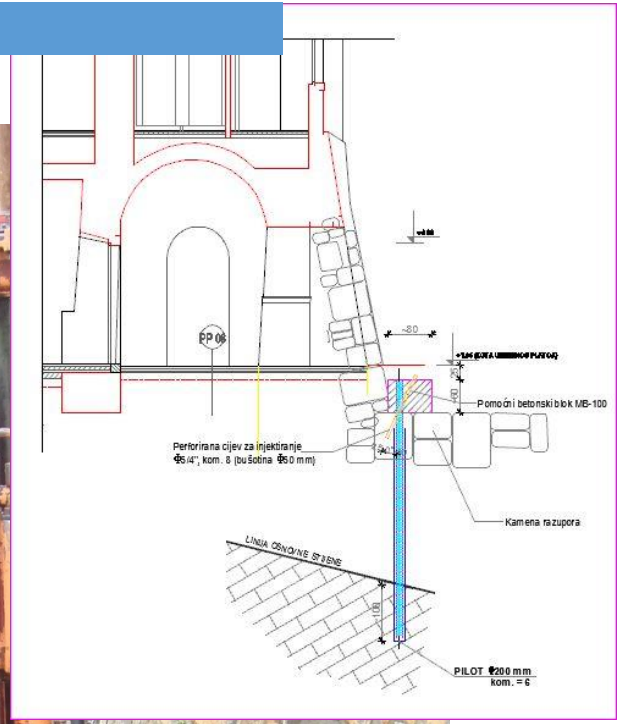

pilot

www.spegra.hr

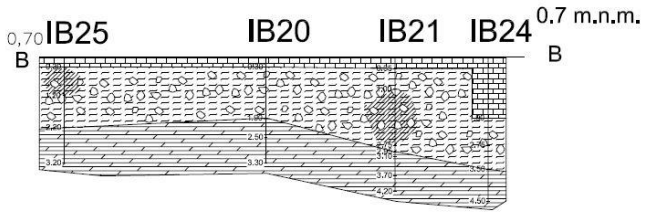
# DETALJI KOD IZVOĐENJA MIKRO PILOTA








## IGP UZDUŽ ZIDA




LEGENDA:

GEOMEHANIČKA SREDINA 1, temeljna konstrukcija, napravljena od nepravilno lomljenog kamena (vapnenac I dolomit) te povezana mortom

GEOMEHANIČKA SREDINA 2, nasip u podlozi temelja veličine krupnog šljunka, skeleti šikoljkaša te biolitski tragovi ubušavanja skupa sa pješkovitom glinom koja je ponegdje odnesena strujama, propadanje uz rotaciju pri bušenju

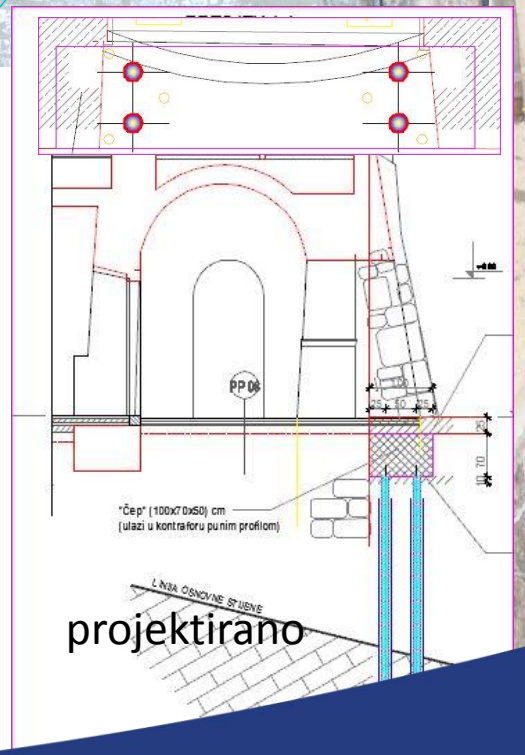
GEOMEHANIČKA SREDINA 3, slabije okršeni dolomit, sive

M 1:100

www.spegra.hr

# DETALJI KOD IZVOĐENJA MIKRO PILOTA



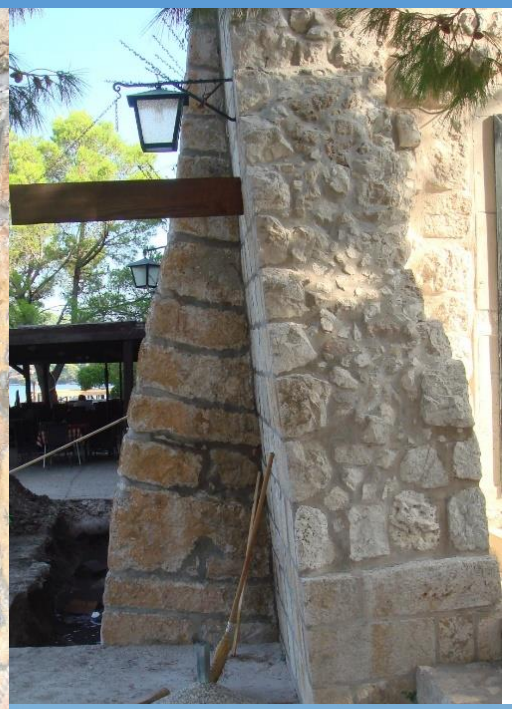


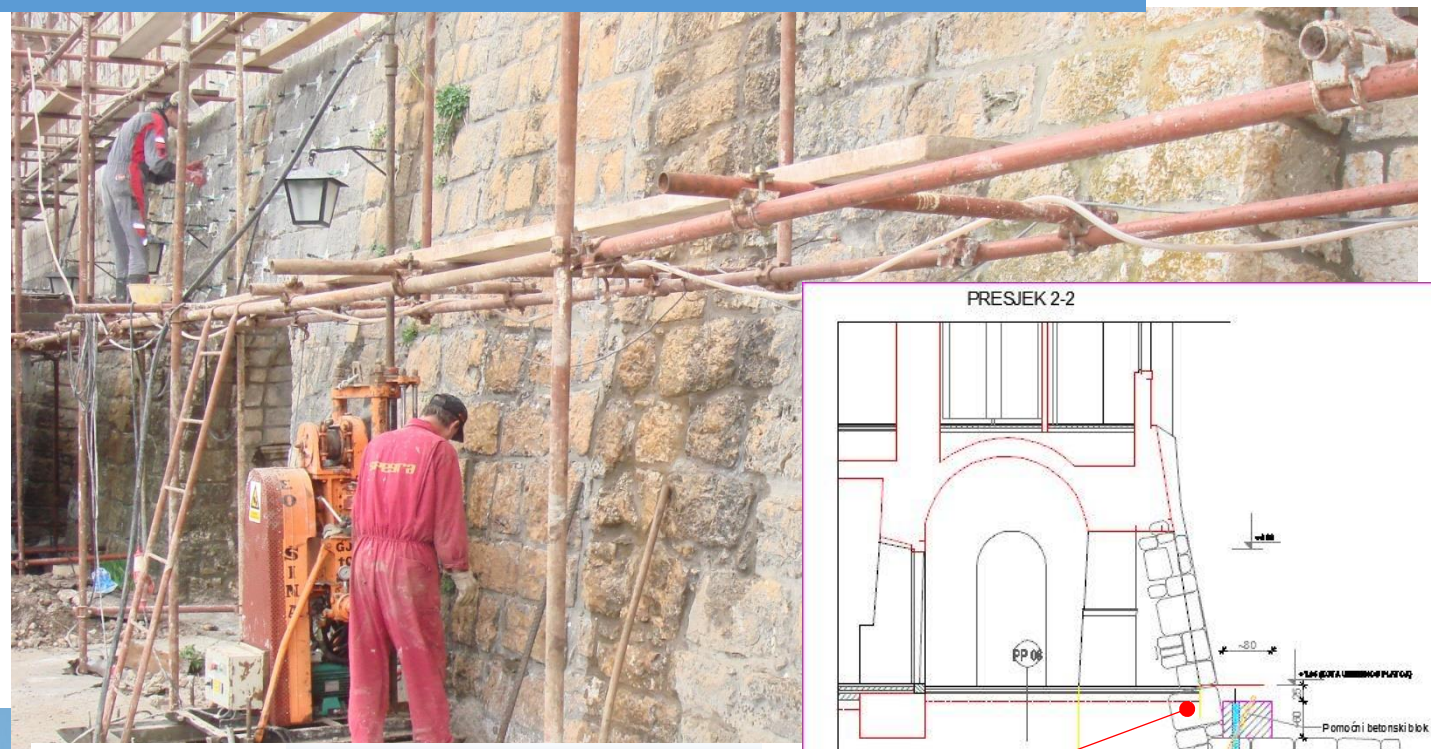
www.spegra.hr

# DETALJI KOD IZVOĐENJA MIKRO PILOTA

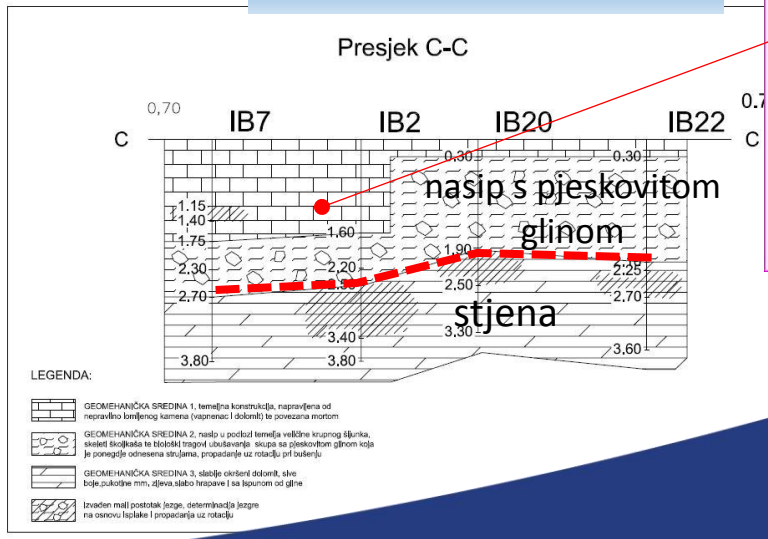
Bušenje s bentonitnom isplakom

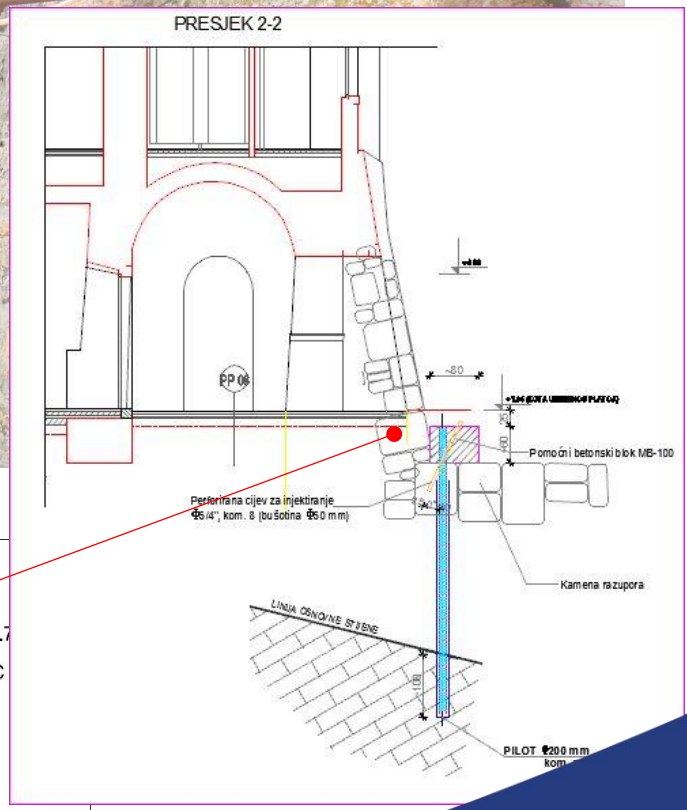
Arm koš za naglanu gredu





## IGP UPRAVNO NA ZID

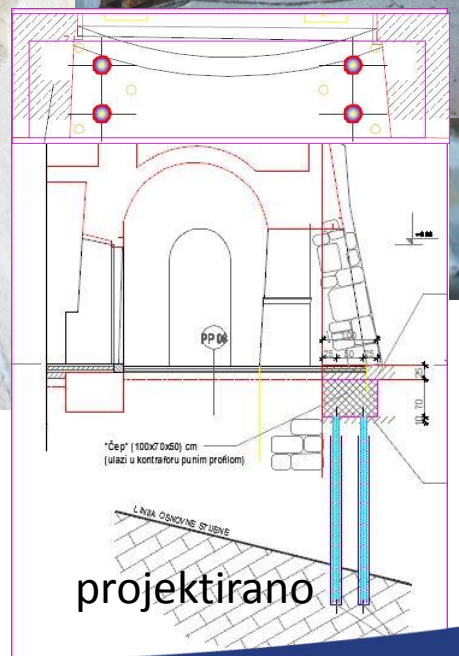



www.spegra.hr

# DETALJI KOD IZVOĐENJA MIKRO PILOTA



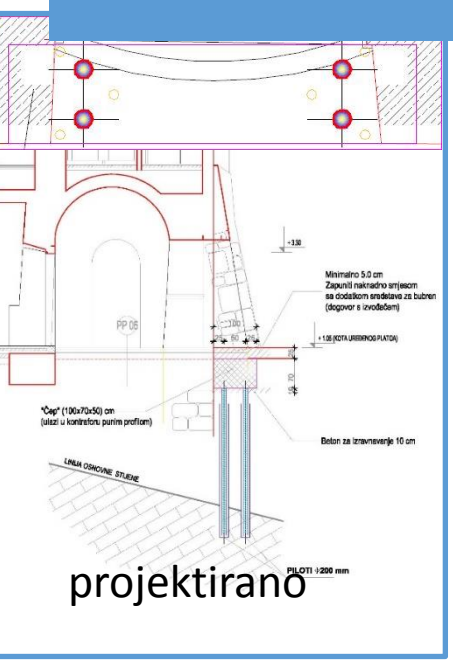



**IZVEDENO U JEDNOJ RAVNI**

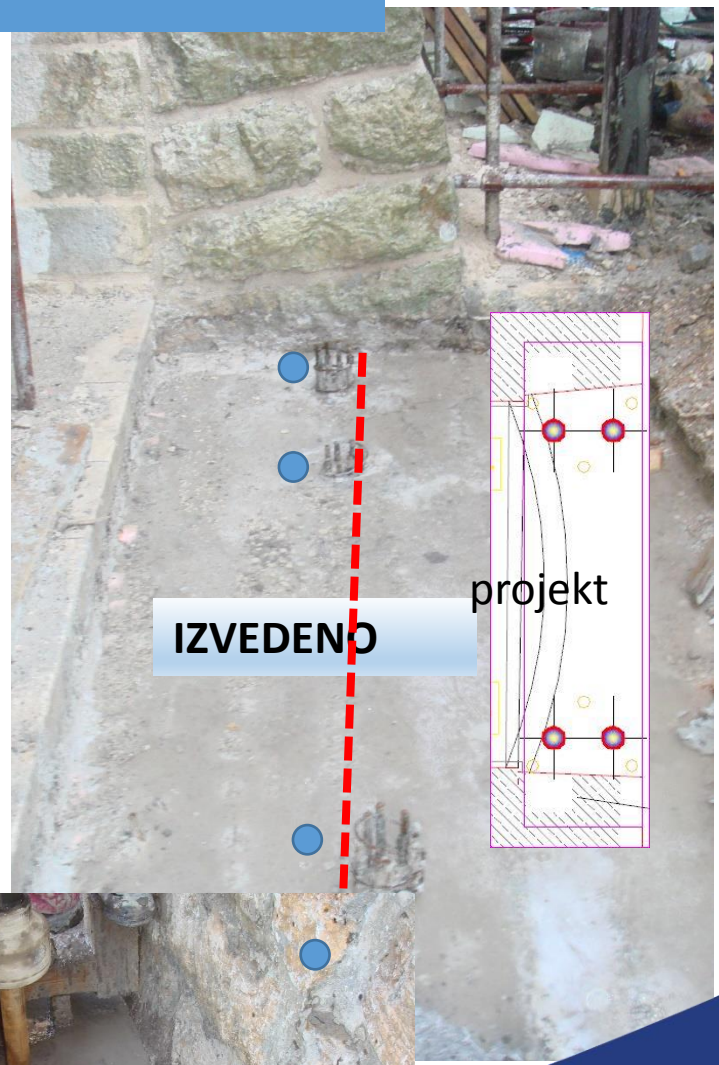
projektirano

www.spegra.hr

# DETALJI KOD IZVOĐENJA MIKRO PILOTA




projektirano



IZVEDENO



projekt

www.spegra.hr

POGLED NA ISTOČNO PROČELJE U ATRIJU

# KNEŽEV DVOR, DUBROVNIK

## KONSTRUKCIJSKA SANACIJA KAMENIH STUPOVA U ATRIJU KNEŽEVA DVORA, ISTOČNO PROČELJE 1. KAT

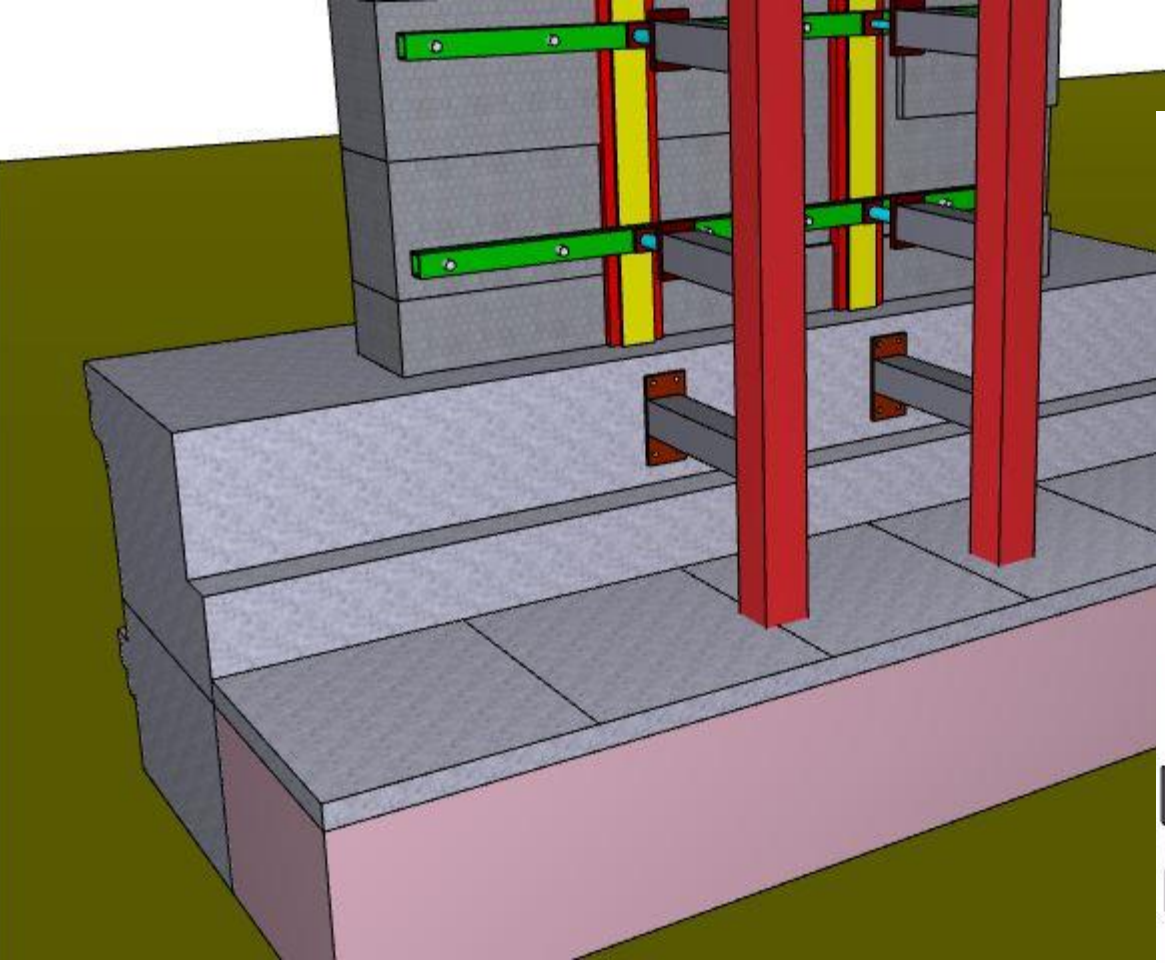
www.spegra.hr



www.spegra.hr

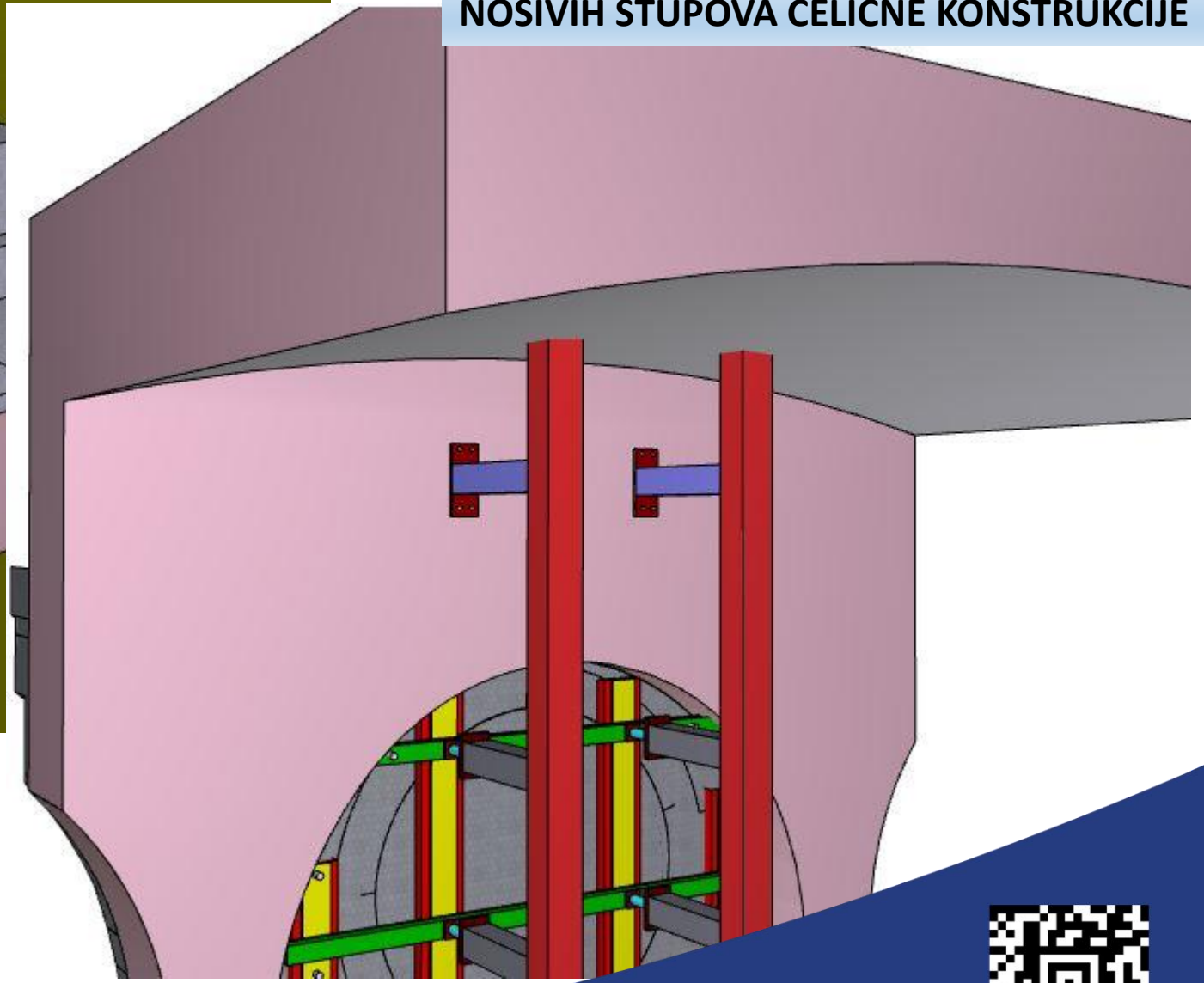
**POZADINA KAMENOG PLATNA**
**OJAČANA SA GFRP KOMPOZITOM**

www.spegra.hr

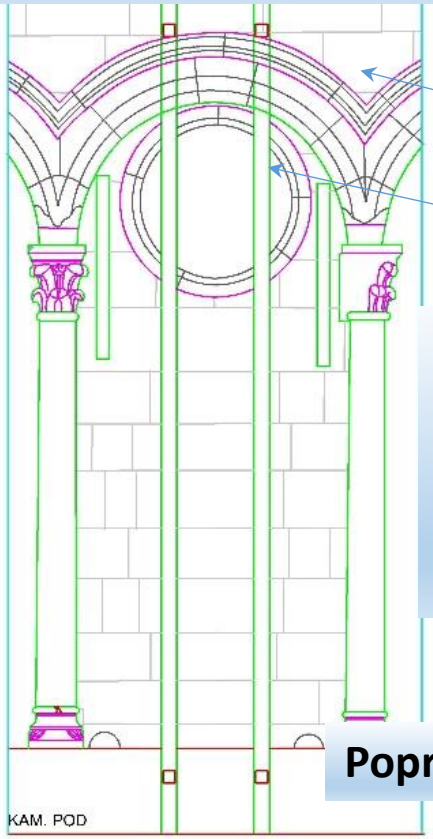


POGLED NA USIDRENJE DONJEG DIJELA NOSIVIH STUPOVA ČELIČNE KONSTRUKCIJE

POGLED NA USIDRENJE GORNJEG DIJELA NOSIVIH STUPOVA ČELIČNE KONSTRUKCIJE



**Osnovna čelična konstrukcija s plošnim podupiračima za pridržavanje kamenog platna**



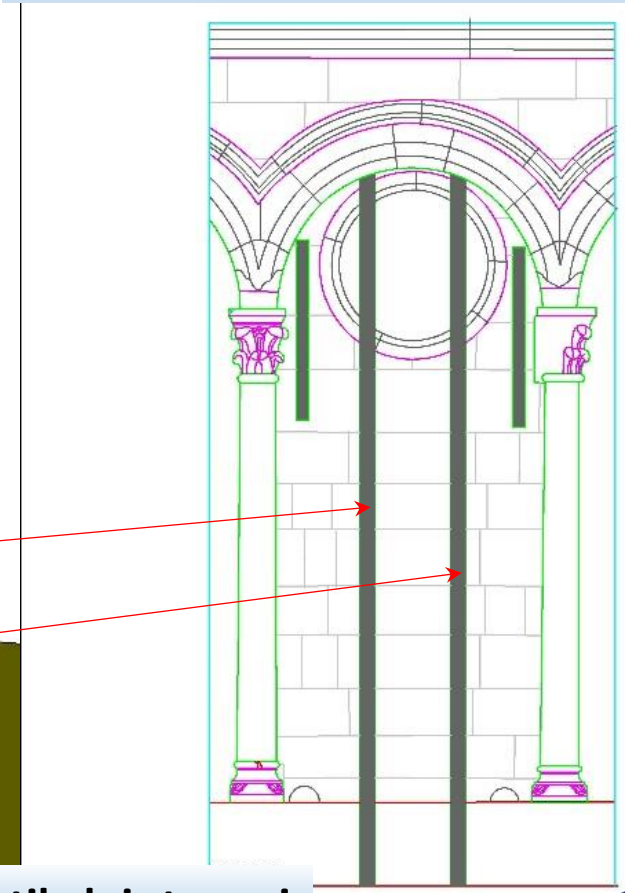

**Staze za poravnanje podloge s vert plošnim podupiračima za pridržanje kamenog platna s neoprenskim uloškom.**

**Popriječni sidreni nosači**

**Horizontalne razupore**

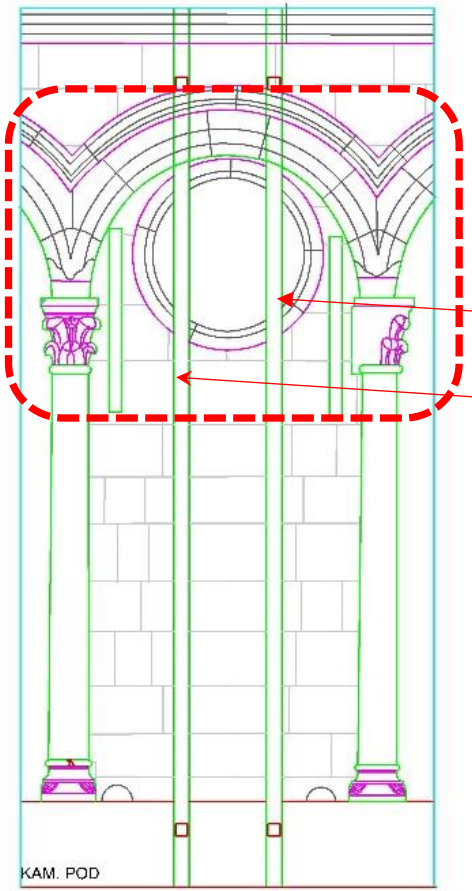
**Vertikalni stupovi**

**Staze za poravnanje podloge radi naljeganja plošnih podupirača za podupiranje platna**

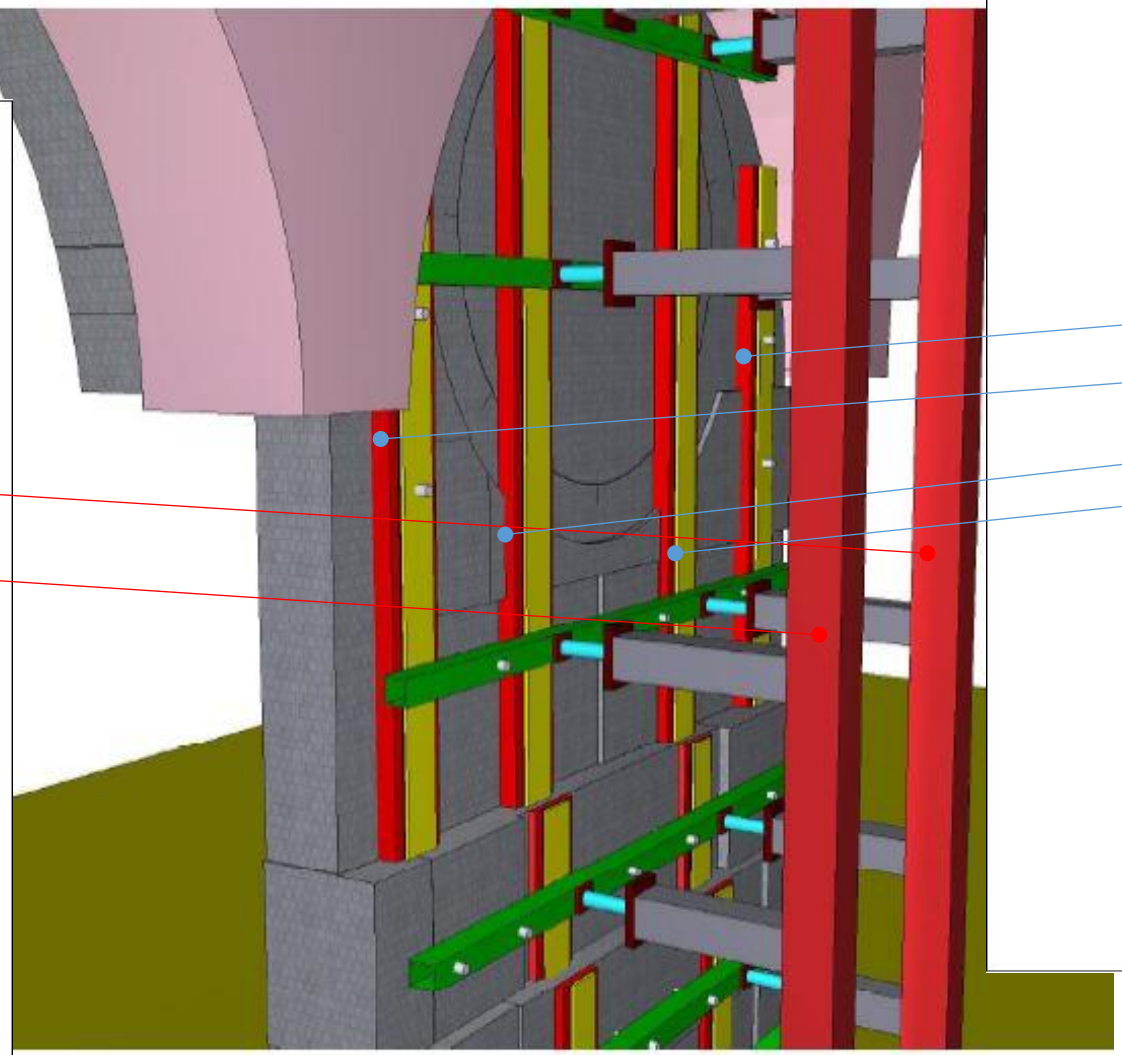


www.spegra.hr

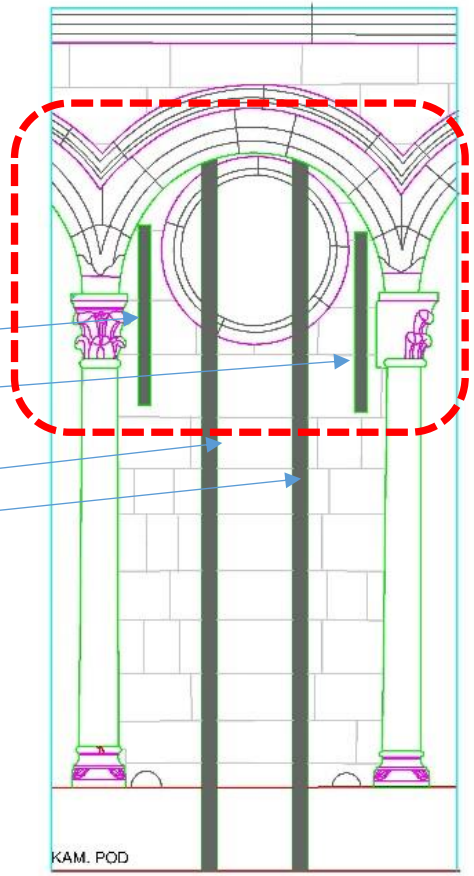
## Gornji dio osnovne čelične konstrukcije sa dvije dodatne čelične staze za podupiranje



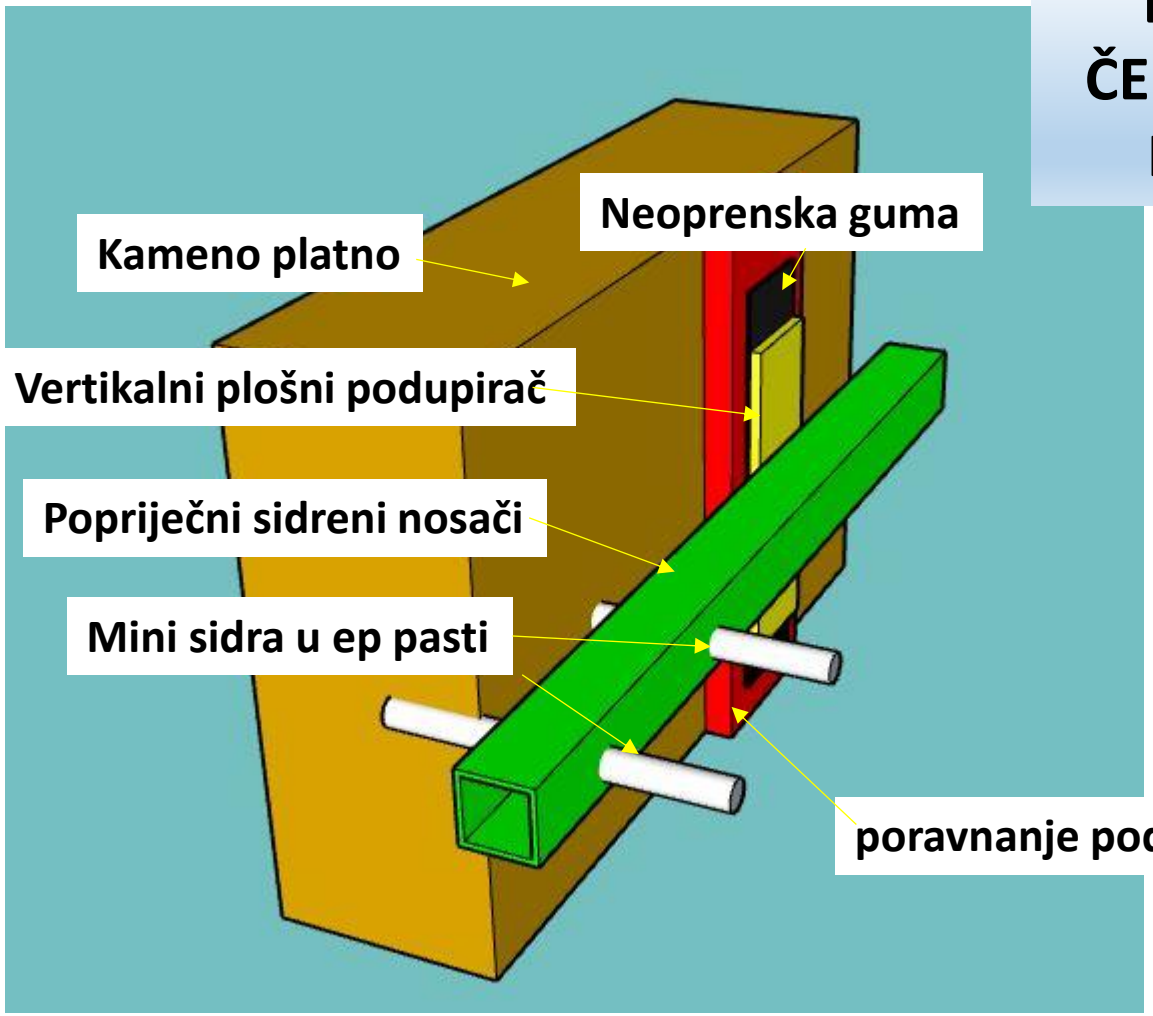

## GORNJI DIO ČELIČNE KONSTRUKCIJE ZA PRIDRŽANJE U ZONI KAMENOG SATA

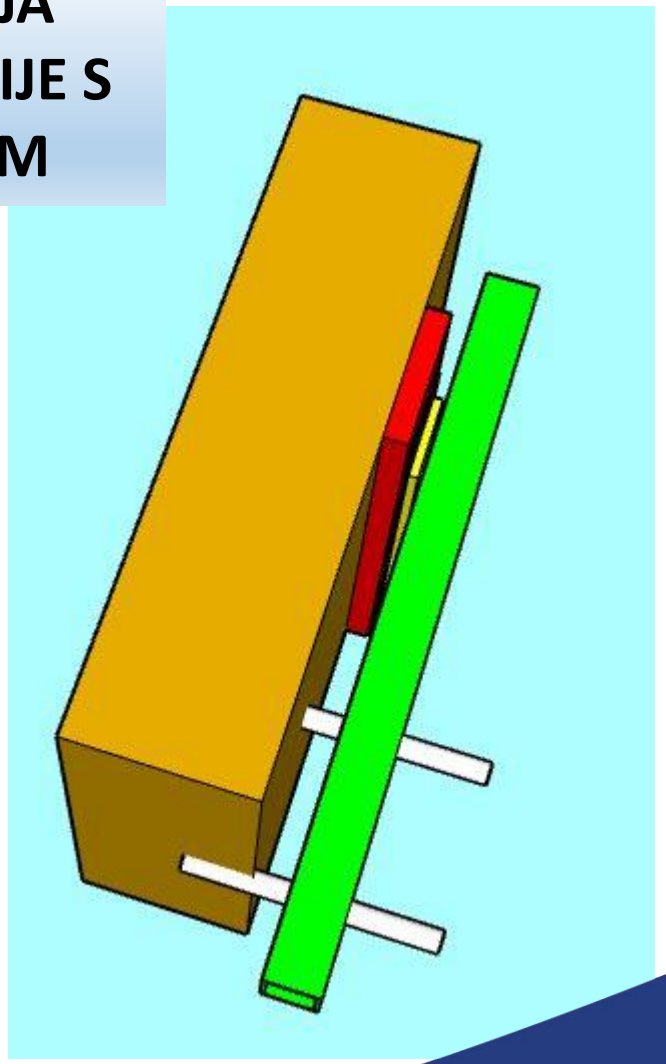


## Podložne staze za oslanjanje čelične konstrukcije

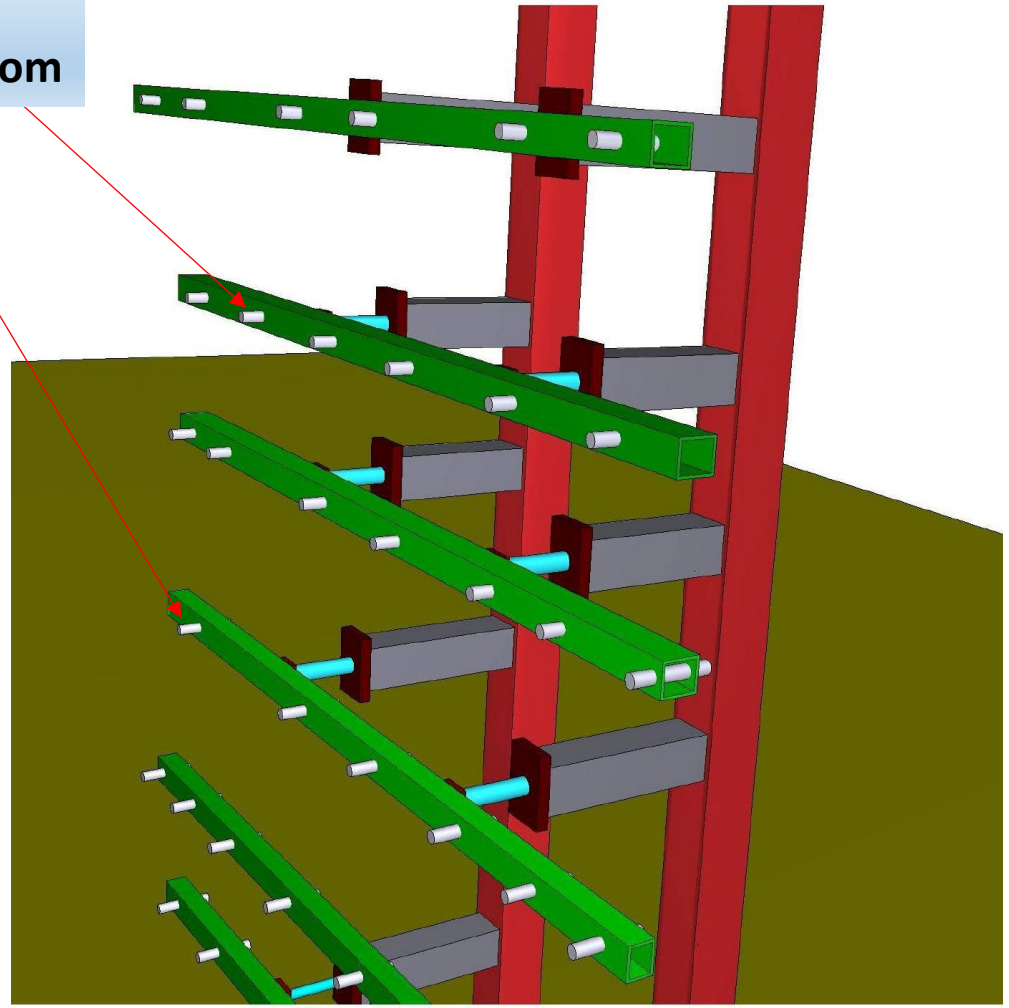


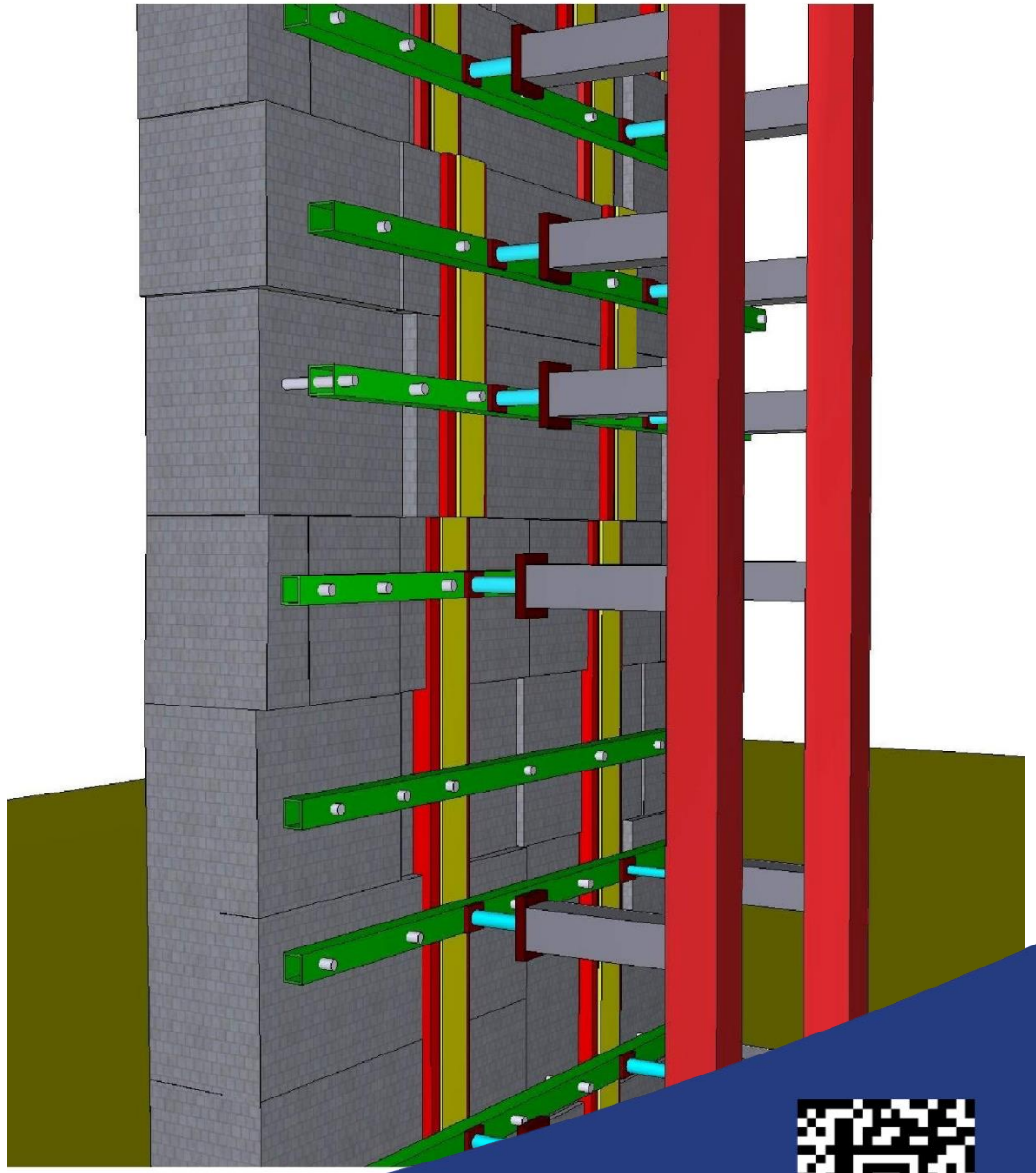
# DETALJ POVEZIVANJA ČELIČNE KONSTRUKCIJE S KAMENIM PLATNOM



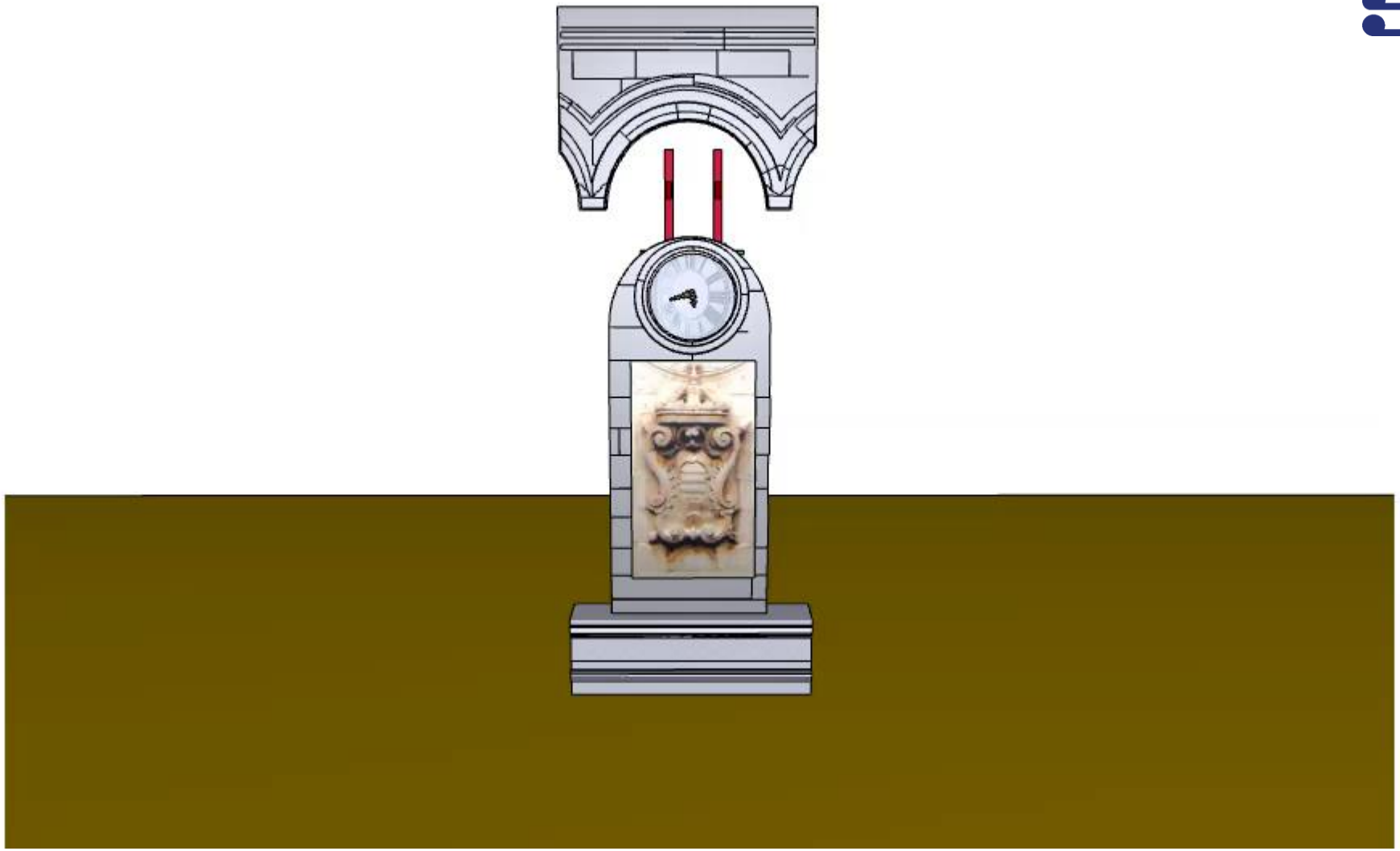
**Mini sidra za povezivanje čelične konstrukcije sa platnom**





www.spegra.hr


www.spegra.hr



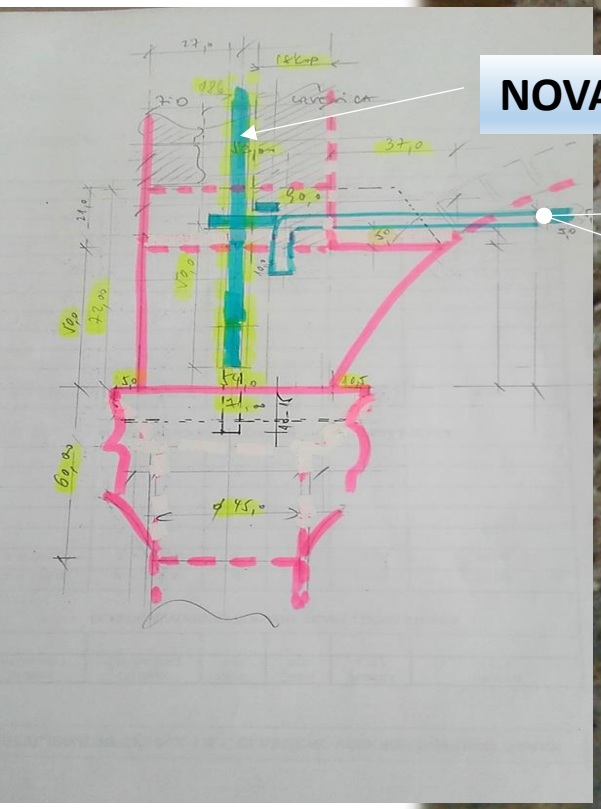
www.spegra.hr

# LJETNIKOVAC KABOGA, DUBROVNIK

## OJAČAVANJE KONSTRUKCIJE SA FRP I FRG KOMPOZITIMA I UGRADNJOM NOVIH NATEGA

www.spegra.hr

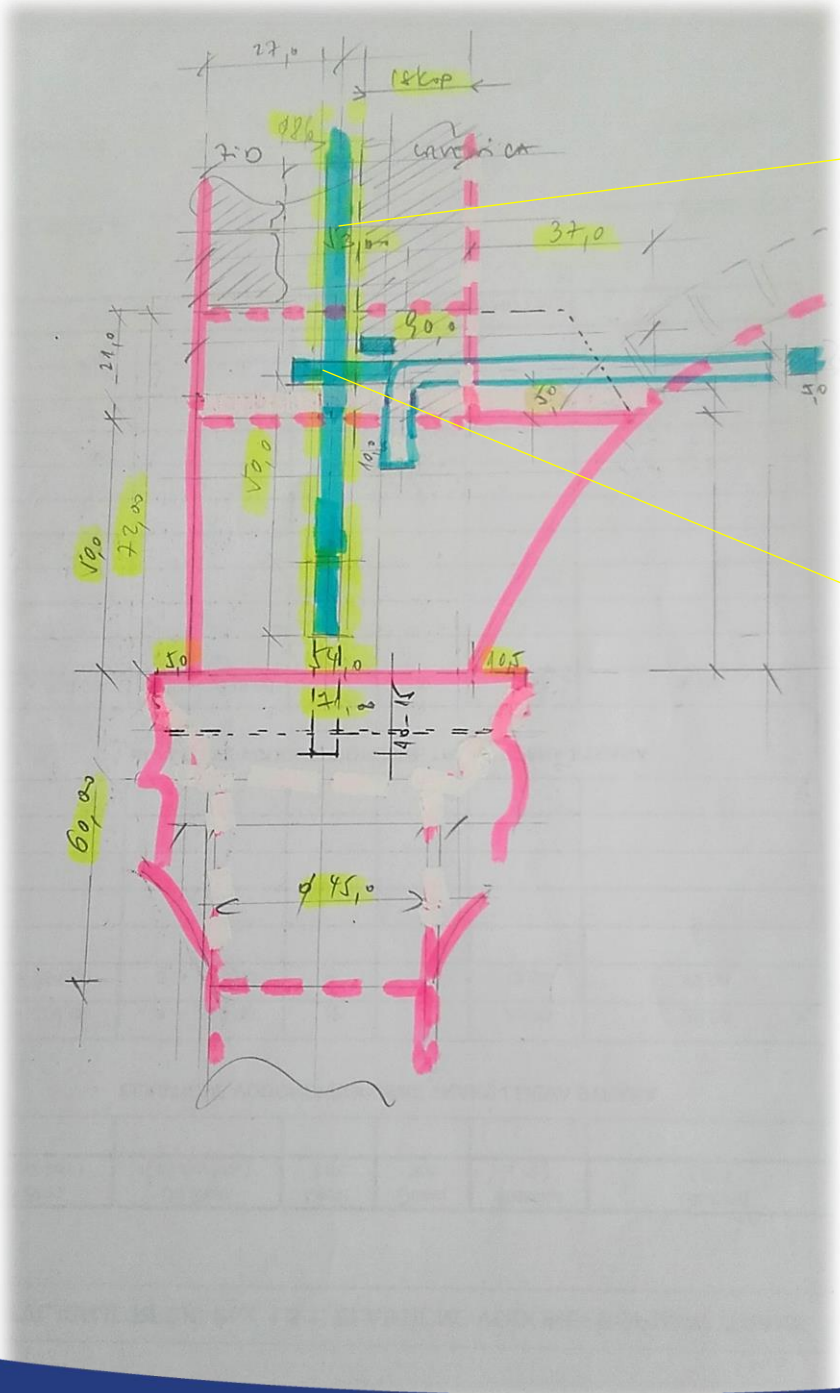

STANJE KAMENIH SVODOVA PRIJE POČETKA SANACIJE

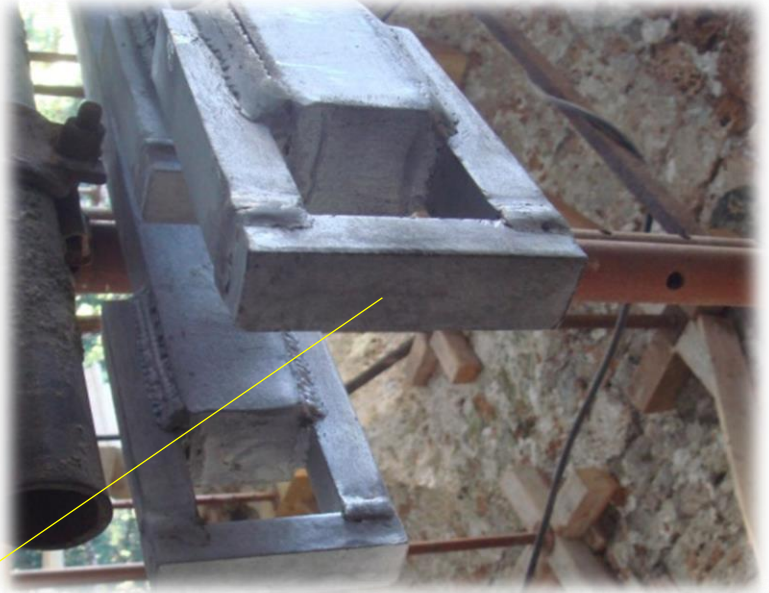


NOVA NATEGA

STARA NATEGA

IZGLED ČELIČNE ZATEGE KOJA JE POD UTECAJEM ATMOSFERLIJA POTPUNO PROPALA





www.spegra.hr

# PRSKANJE BIOCIDNIM SREDSTVIMA ZA ZAŠTITU KAMENA OD POJAVLJIVANJA MIKROORGANIZAMA

www.spegra.hr

spegra

# INJEKTIRANJE

www.spegra.hr

# REPROFILIRANJE KAMENIH SVODOVA REPARATURNOM MORTOM

www.spegra.hr

# UGRADNJA KARBONSKE TKANINE ZA OJAČANJE KAMENIH SVODOVA

www.spegra.hr

spegra

# RASTER KARBONSKIH POJAČANJA

www.spegra.hr

spegra

**POGLED NA TRIJEM S KARBONSKIM POJAČANJEM**

www.spegra.hr

PARTNER SUVREMENE OBNOVE

2018 NOSITELJ AAA CERTIFIKATA Bisnode

ISO 9001
ISO 14001
OHSAS 18001

# HVALA NA POZORNOSTI !

www.spegra.hr