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DVOJNA VRATA, PULA

KONZERVATORSKO-RESTAURATORSKI OSVRT

THE DOUBLE GATE AT PULA

A CONSERVATION-RESTORATION REVIEW

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UDK 725.96: 7.025.4](497.5 Pula)
Prethodno priopćenje - novitates
Primljeno: 5. 7. 2011.
Odobreno: 7. 9. 2011.

UDC 725.96: 7.025.4](497.5 Pula)
Preliminary Report - Novitates
Received: July 5, 2011
Approved: September 7, 2011

U zadnjih je nekoliko desetljeća zabilježeno propadanje i onečišćenje spomeničkih površina, i to i u Hrvatskoj i u inozemstvu. Unatoč čestom mišljenju laika, ne radi se ni o naglom niti o ubrzanom vidu propadanja. Činjenica je da se zadnjih desetljeća jednostavno počela pridavati velika pažnja spomenicima kao povijesnim vrijednostima koje treba očuvati, a slijedom toga i njihovom stanju. U želji da se dokumentira stupanj degradiranosti i onečišćenja pulskih spomenika, odlučili smo provesti obilazak. Počeli smo s antičkim spomenicima, konkretno Dvojnim vratima. Cilj je oformiti bazu podataka u vidu tekstualnih zapisa, grafičkih degradacijskih tabli te fotodokumentacije svih primijećenih vrsta degradacija. Namjera je članka da cilj rada iznese u pojednostavljenom i sažetom obliku, uz dodatak solucija za očuvanje spomenika.

In the last few decades we not only witnessed dilapidation but also a dirtying of surfaces belonging to monuments, and this applies to Croatia as well as abroad. Despite the frequent opinion expressed by laymen, this is neither a sudden nor an accelerated process of deterioration. The fact remains that over the past several decades a lot of attention began to be focused on monuments as historical assets that need to be preserved, thus invariably touching on their state of preservation. Wishing to document the degree of deterioration and dirtying of the monuments at Pula, we embarked on a tour. We began with monuments from the Roman period, i.e., with the Double Gate to be precise. Our goal is to set up a data base consisting of written reports, graphical tables showing degradation, and photo documentation showing the entire range of degradation processes that we observed. With this article we want to expose and explain the goals of these endeavors in a simplified, summarized form, providing on the way the solutions needed for the preservation of these monuments.

KLJUČNE RIJEČI: Dvojna vrata, degradacije, grafička dokumentacija, restauratorsko-konzervatorski prijedlozi

KEY WORDS: the Double Gate, degradation, graphical documentation, restoration-conservation proposals

1. Uvod

Višegodišnjim radom u konzervatorsko-restauratorskoj struci primijećeno je da su nepokretni spomenici kulture izloženi tisućljetnim utjecajima vremena i čovjeka, koji su uzrokovali mnogobrojna oštećenja i degradacije, a ne posvećuje im se dovoljna pažnja. U načelu se na njih obrati pozornost ako postanu od svjetske estetsko-povijesne važnosti ili ako se na njima pojave izrazitija strukturalna oštećenja uslijed kojih im prijete propadanje.

U želji da se pulskim spomenicima pruži primjerena skrb organizirali smo njihov obilazak, ne bismo li zabilježili u kojem se stanju nalaze te obratili pozornost na sve uvjete i moguće probleme, kao i na sve eventualno potrebne radove i zahvate.

Iako bi se možda očekivalo da počnemo s poznatijim pulskim spomenicima, poput Zlatnih vrata ili Augustovog hrama, odlučili smo započeti s manje poznatim antičkim pulskim vratima, Dvojnim vratima, jer se i inače njima (kao i Herkulovim vratima) kroz povijest pridavala manja pažnja. Upravo to su pokazala i razna bibliografska i arhivska istraživanja, koja ih često uopće ne spominju ili je njihovo postojanje naznačeno tek kratkom crticom.

1.1. Povijesni osvrt

Dvojna vrata izgrađena su krajem II. st. na ostacima starijih rimskih vrata na sjeveroistočnoj strani gradskih zidina u Puli (Matijašić, Buršić-Matijašić, 1996, str. 61), u današnjoj Carrarinoj ulici, stotinjak metara sjeverno od Herkulovih vrata.

Prvobitno, vrata su imala trapezoidni tlocrt koji se pružao prema unutrašnjosti gradskog areala, ali danas je očuvan samo dvolučni fasadni ulaz (Mlakar, 1978, str. 28). Vrata su ukrašena samo s vanjske strane, s tri polustupa kompozitnih kapitela. Lukovi su jednostavno profilirani, s istaknutim središnjim zaglavnim kamenom. Odmah iznad lukova nalazi se jednostavni arhitrav, iznad kojega je izbočeni vijenac bogato ukrašen profilom s jajolikim nizom te profilom s vegetativnim oblicima. Oba luka u stražnjem dijelu imaju vertikalni prorez kroz koji su se spuštale rešetke za zatvaranje vrata.

Kao i svi pulski spomenici, kroz skoro dva tisućljeća povijesti, Dvojna vrata doživjela su mnogobrojna oštećenja i pretrpjela niz zahvata. No, gotovo je nemoguće pronaći podatke o događajima koji se vezuju uz ovaj spomenik i koji bi mogli biti važni za shvaćanje njegova današnjeg stanja.¹

¹ Tijekom 2010. godine, a vezano za bolje upoznavanje povijesnog konzervatorskog stanja pulskih spomenika, provedeno je pretraživanje svih Kandlerovih spisa koji se čuvaju u Sveučilišnoj knjižnici u Puli.

1. Introduction

Through a long period of work in the field of conservation and restoration of monuments, it was observed that the immovable cultural monuments, exposed to millennial weather-provoked and man-made influences, suffered countless damages and degradations as a consequence thereof, all of which failed to attract the necessary attention to solve these issues. As a rule, such monuments grab the spotlight only if they become world-renowned from an aesthetical-historical standpoint, or if they are victim of more pronounced structural damages that could result in their dilapidation.

To bestow upon the monuments of Pula the care they rightly deserve, we decided to tour them and to record their present state, in order to be able to focus on all the conditions and potential problems, and on all the eventually required works and interventions.

Even though it might have been expected that we begin our tour with the more famous monuments on offer at Pula, like the Porta Aurea or the Temple of Augustus, we nonetheless decided to start with a lesser known Roman gate at Pula, the Double Gate, as throughout history it likewise suffered from lack of attention (as was also the case with Hercules' Gate). And that is precisely what we concluded on the basis of bibliographic and archival research that often failed even to mention these monuments, or else their existence was only mentioned in the briefest possible manner.

1.1. A historical review

The Double Gate was erected towards the end of the 2nd century on the remains of an even older Roman gate located on the northeastern side of the defensive wall at Pula (Matijašić, Buršić-Matijašić, 1996, p. 61), in present-day Carrara Street, approximately one hundred meters from Hercules' Gate.

Originally, this gate featured a trapezoidal ground-plan that extended towards the interior of the urban area; however, at present only the two-arched façade entrance is preserved (Mlakar, 1978, p. 28). The gate is only decorated from the exterior side, with three semi-columns with composite capitals. The arches are profiled in a simple manner, featuring an emphasized central voussoir. A simple architrave is located immediately above the arches, situated above which is a drawn out cornice richly decorated with a profile featuring a series of ovoid ornaments, and a profile with vegetal forms. Both arches are equipped with a vertical slot in the posterior section, used to lower the grating to close the gateway.

As was the case with all monuments from Pula in the course of almost two millennia of history, the Double Gate suffered many damages and went through a series

Poznato je da su pulske zidine u više navrata rušene, građene i ponovno rušene. Godine 1299. građanstvo Pule obnavlja zidine, ali već 1300. obećava da će obnovljene zidine srušiti (Kandler, 1986, str. 844). Ovakvi su radovi zasigurno utjecali i na stanje Dvojnih vrata, ali ona se u dokumentima ne spominju.

Godine 1818. Pietro Nobile obavlja iskopavanja u amfiteatru, a tom prilikom radnike šalje i da iskopaju luk koji se 1816. tek nazirao – to su bila Herkulova vrata. U tekstu potom napominje da je identična situacija s drugim, Dvojnim vratima, jer je vidljiv tek njihov gornji dio s dvije arkade, te predlaže da ih se iskopa (Rusconi, 1926, str. 343–358). Iz tog je zapisa vidljivo da su 1816. godine Dvojna vrata bila zatrpana, što se sigurno vezuje i uz epizode rušenja i ponovnog građenja gradskih zidina. S druge strane, budući da su vjerojatno dugi niz godina (pa i stoljeća) bila zatrpana, relativno su dobro očuvana u nižim dijelovima, dok su im nedostajali oni gornji, ukrašeni.



Sl. 1 Dvojna vrata početkom 19. stoljeća (T. Allason, 1819.); pretpostavljeno stanje spomenika kakvim ga je Nobile vidio prilikom iskopavanja.

Fig. 1 The Double Gate at the beginning of the 19th century (T. Allason, 1819); the presumed state of the monument as seen by Nobile during the excavations.

Pretpostavlja se da su 22. lipnja 1853. Dvojna vrata bila vidljiva (barem gornji dio), s obzirom da se u jednom dokumentu potvrđuje da Pietro Artusi prima područje iskopavanja oko Dvojnih vrata u najam (Kandler, Knjiga 6, 1853). Iz ovoga se dokumenta može iščitati da je teren s vanjske strane spomenika bio poljoprivredno obrađen.

Kandler 21. studenog 1857. izjavljuje da se ne protivi nakani austrijske mornarice da sruši pulske zidine (Kandler, Knjiga 6, 1857). I ti su zahvati sigurno imali utjecaja na sama vrata, ali s obzirom da ne postoji nikakva dokumentacija, nemoguće ih je povezati s prisutnim degradacijama.

of interventions. However, it is well-nigh impossible to discover any information regarding events that are tied with this monument and that could be of use to comprehend its present-day condition.¹

It is known that the defensive wall around Pula was repeatedly destroyed, re-built, only to be renewedly ravaged. In 1299, the inhabitants of Pula renewed the wall, but already by 1300 it looks like the rebuilt defensive wall will be torn down again (Kandler, 1986, p.844). Works like this surely had an effect on the condition of the Double Gate, but they are not mentioned anywhere in the documents.

In 1818, Pietro Nobile carried out his excavations in the amphitheater; on that occasion he deployed a group of workers to excavate an arch that in 1816 was barely visible – this was the Hercules' Gate. He later wrote that there was an identical situation with the Double Gate, as only its upper section consisting of two arcades was visible, and he suggests that they should be excavated (Rusconi, 1926, pp. 343–358). From these records it is clear that in 1816 the Double Gate was covered with earth, a state that can surely be connected to episodes of demolition and renewed erection of the defensive wall around Pula. On the other hand, because the Double Gate was under a layer of earth for many years (indeed centuries) it is relatively well preserved in its nether sections, while the upper sections that were decorated are missing.

It is to be presumed that on June 22, 1853, the Double Gate was visible (at least the upper section), as in one of the documents it is stated that a certain Pietro Artusi rented the excavation area around the Double Gate (Kandler, Book 6, 1853). Also apparent from this document is the fact that the terrain on the exterior side of the monument was used as agricultural land.

On November 21, 1857, Kandler declares that he is not opposed to the declared intention of the Austrian Navy to demolish the protective wall around town (Kandler, Book 6, 1857). Works like this surely influenced the gate in some manner; however, due to the missing documentation we cannot connect this to any present degradations.

On March 31, 1862 (Kandler, Atti, No. 278, Volume 3), the municipal authorities informed Kandler about excavations around the Double Gate, the military forces refraining from making any reports about these works or the discovered Roman fragments. The authorities likewise reported two demolished pilasters that were in that area, in order to use them in some other location. On

¹ During 2010, a search of all of Kandler's writings that are kept in the University Library at Pula was conducted, in order to get better acquainted with the historical state of conservation of the monuments at Pula.

Dana 31. ožujka 1862. (Kandler, Atti, N° 278, svezak 3) gradska uprava prijavljuje Kandleru iskopavanja oko Dvojnih vrata, pri čemu vojne snage ne javljaju ništa o radovima ni pronađenim antičkim ulomcima. Također, prijavljuju da su srušena dva pilastra koja su ondje postojala, ne bi li ih se iskoristilo na drugoj lokaciji. Dana 8. lipnja 1862. (Kandler, Atti, svezak 3) Kandler odgovara da nije u njegovoj nadležnosti brinuti o takvim pitanjima. I ovdje se nastavlja situacija s manje zanimljivim pulskim spomenicima. Iako je vrlo vjerojatno da Kandler nije ni smio izjaviti da se protiv zahvatima vojnih snaga, nije bilo nemoguće pratiti iskopavanja te barem zabilježiti što je viđeno, pronađeno i u kakvom se stanju spomenik nalazi. Nažalost, Kandler se za takvo dokumentiranje nije odlučio.

Jedini je podatak koji konkretno spominje restauratorsko-konzervatorski problem Dvojnih vrata u članku od 9. ožujka 1887., gdje inženjer Rodolfo Pons u *Eco di Pola*, godina II, broj 60, ističe “da će nestati katranske mrlje koje nagrđuju pilastre Dvojnih vrata” (“Chiudo col dirle infine, che a Dio piacendo, spariranno anche quelle macchie bituminose che decorano i pilastri della Porta Gemini, e che al forastiero appariscono come timbri di profanazione applicati a ricordi che la civiltà impone di rispettare.”). Iako nije sigurno kada su mrlje odstranjene, usporedbom fotografije iz 1900. godine (slike 2 i 3), na kojoj su mrlje vidljive, s kasnijim fotografijama primjetno je da su mjesta koja su nekad bila prekrivena katranom smečkasto-narančaste boje.



Sl. 2 Dvojna vrata početkom 20. stoljeća.
Fig. 2 The Double Gate at the beginning of the 20th century.

June 8, 1862 (Kandler, Atti, Volume 3), Kandler responds that dealing with such issues does not fall under his jurisdiction. And this is where the situation with Pula's less important monuments continues. Although it is to be assumed that Kandler was very probably not even allowed to voice his opposition to the works planned by the military, it was not impossible to follow the excavations and to at least record what had been seen or discovered, and to report on the state of the monument. Unfortunately, Kandler decided against this kind of record-keeping.

The only reference that concretely mentions the restoration-conservation issues related with the Double Gate is to be found in an article dated March 9, 1887, in which an engineer, Rodolfo Pons, in the *Eco di Pola*, Year II, No. 60, was quoted as saying “that the ugly tar stains that deface the pilasters of the Double Gate will disappear” (“Chiudo col dirle infine, che a Dio piacendo, spariranno anche quelle macchie bituminose che decorano i pilastri della Porta Gemini, e che al forastiero appariscono come timbri di profanazione applicati a ricordi che la civiltà impone di rispettare.”). Even though we do not know when these stains were removed, by comparing photographs taken in 1900 (Fig. 2 and 3), where the stains are clearly visible, with those taken subsequently, it can be seen that the areas once covered with tar are now brownish-orange in color.

Among the works that were undertaken on the Double Gate are also the replacements of some stone parts of the monument, which were either extremely worn out or cracked. Even though bibliographies state that these works were carried out in the period of Kandler's mandate as conservator, the author of this article was not able to find any documents which mention them. It can nevertheless be assumed that it was Kandler who ordered this repair work on the Double Gate, because at the beginning of his mandate the gate was covered with earth, only to be completely excavated by the end of it. A few years ago, one such added part (made of two fragments) severed itself almost completely from the monument, only to be subsequently removed from it due to security precautions, and stored in the Archaeological Museum of Istria where it is located to this very day (Fig. 4). From these two fragments can be observed that the repairs performed with newly inserted stone parts were executed by first gluing together such an inserted part, most probably using some animal based glue, and then filling the joints around it with mortar. It can also be added, that the majority of such inserted parts are brownish nowadays, which could indicate that precisely these parts were the ones coated with tar that was removed at the beginning of the 20th century.



Sl. 3 Dvojna vrata danas. / Fig. 3 The Double Gate at present.

Kroz povijest radova na Dvojnim vratima neki su izuzetno istrošeni ili ispucali kameni dijelovi zamijenjeni novima. Iako se u bibliografijama navodi da su ti zahvati izvedeni u vrijeme Kandlerova mandata kao konzervatora, autorica teksta nije uspjela pronaći dokumente koji ih spominju. Ipak, s obzirom da su za početka Kandlerova mandata vrata bila zatrpana, a krajem mandata otkrivena, moguće je pretpostaviti da je upravo on naložio njihov popravak.

Prije nekoliko godina jedna se takva nadogradnja (iz dva ulomka) gotovo u potpunosti odvojila od spomenika te je iz sigurnosnih razloga odstranjena i pohranjena u Arheološkom muzeju Istre, gdje se i danas nalazi (slika 4). Kod ova je dva ulomka vidljivo da su popravci novim kamenim umecima izvedeni na način da je umetak zalijepljen, najvjerojatnije životinjskim ljepilom, a zatim rubno fugiran mortom. Također, većina je umetnutih dijelova danas smečkaste boje, što bi moglo značiti da su upravo ti dijelovi premazani katranom koji je zatim početkom 20. stoljeća odstranjen.

Iako nije dokazano korištenje katrana pri restauratorskim zahvatima u povijesti, moguće je da je u to vrijeme odlučeno dijelove premazivati katranom ne bi li se dobilo na hidrofobnosti materijala, jer su izvođači radova sumnjali u kvalitetu umetnutog kamena u odnosu na postojeći.



Sl. 4 Detalj pozicije odstranjenih kamenih nadogradnji.
Fig. 4 A detail showing the position of subsequent stone additions that were removed.

Postoji još jedan oblik zahvata na spomeniku koji nije moguće datirati, a to su obilne cementne zakrpe i premazi. S obzirom da se cement počinje koristiti krajem 19. stoljeća, moguće je da je postavljanje takvih zakrpa naložio Kandler, ali i da su korištene kasnije.

2. Degradacija Dvojnih vrata

Danas je na Dvojnim vratima moguće vidjeti paletu degradacija tipičnih za antičke spomenike smještene u urbanim sredinama. One su uglavnom vezane uz atmosferske utjecaje, zagađenje i vandalizam. Srećom, nisu vidljiva bitna statička oštećenja.

Na Dvojnim vratima moguće je razlikovati dvije velike grupacije degradacija, a to su estetske i strukturalne. Kod estetskih je degradacija, kako i sama riječ kaže, problematika vezana uglavnom uz narušavanje izgleda spomenika. Kod strukturalne je degradacije naznaka na opasnosti za očuvanje dijelova spomenika. Naravno, ove se dvije grupe degradacija i preklapaju, tako je crna inkrustacija istovremeno i estetska i strukturalna degradacija, a isto se može reći za vegetaciju i aktivne biološke naslage.

Estetske su degradacije grupirane u dvije vrste: biološki film i mrlje.

Strukturalne su degradacije: prisutnost metalnih dijelova, vegetacija i aktivne biološke patine, cementne ispune, crne inkrustacije, alveolizacije, lomovi i nedostajući dijelovi.

Odluka o načinu prikazivanja degradacija na grafičkim priložima donijeta je isključivo u odnosu na preklapanje degradacija, na način da na jednom nacrtu ne bude prisutno više degradacija na istome mjestu. Stoga je primjetno da se na istim nacrtima nalaze zajedno estetske i strukturalne degradacije te da su na dva različita nacrtu grupirane aktivne biološke patine i biološki film.

Općenito gledajući, na Dvojnim vratima izuzetno su raširene degradacije vezane uz lišajeve, bilo u vidu biološkog filma, bilo u vidu aktivne biološke patine, te one koje se manifestiraju u gubitku originalnog materijala, a posebno fenomen alveolizacije. Također je raširena i pojava crnih inkrustacija, koje srećom nisu veće debljine.

2.1. Mrlje, biološki film i crne inkrustacije

2.1.1. Mrlje

Mrlje na Dvojnim vratima u većini slučajeva uzrokovane su katranom, odnosno ostale su nakon odstranjivanja katranskih premaza. Početno je smatrano da su ulomci crvenkaste boje zbog kontakta sa zemljom crvenicom, ali usporedbom povijesnih fotografija

Although the use of tar for restoration purposes was never corroborated in history, it is possible that it was decided to give these parts a coat of tar at the time, in order to enhance the hydrophobic quality of the material; this because the restorers had serious doubts about the quality of the inserted stone as compared with the existent one.

There is still another form of intervention on the monument that we are not in a position to date; these are the numerous places that were either patched with cement or were given a coat thereof. It is possible that these cement patches were ordered by Kandler, or else they were made later on, because cement began to be used towards the end of the 19th century.

2. The degradation of the Double Gate

Scores of degradations that are typical for Roman monuments located in urban areas can be nowadays observed on the Double Gate. These are mainly connected with atmospheric influences, pollution and vandalism. Fortunately, there are no serious static damages that are visible.

Two large groups of degradations can be spotted on the Double Gate, those aesthetical and those structural ones. As the word itself implies, degradations of an aesthetic nature tend to disturb the appearance of the monument. Structural degradations, on the other hand, put the preservation of certain parts of the monument in jeopardy. Naturally, these two groups of degradations also overlap, in this manner we consider a black incrustation an aesthetic as well as a structural degradation, and the same is the case when speaking about vegetation and active biological layers.

Aesthetic degradations are grouped into two subgroups: biological film and stains.

Structural degradations are: the presence of metal parts, vegetation and active biological patinas, cement fillings, black incrustations, alveolization, breakages and missing parts.

The decision regarding the mode of display of these degradations on graphical charts was made exclusively in relation to the overlapping of degradations, in a way that prevents several degradations being present on one chart at the same place. We can therefore notice that the same charts have aesthetic and structural degradations presented together, and that grouped on two different charts are active biological patinas and biological film.

In general, we can observe that the Double Gate is extremely prone to degradations involving lichen, be that in the form of a biological film or as an active biological patina, and those that manifest themselves in the loss of original material, and especially the alveolization phenomenon. Black incrustations are likewise widespread, which, fortunately, are not very thick.

i uvidom u podatke koje Pons iznosi u Eco di Pola 1887. zaključeno je da se radi o katranskim mrljama. Sporadično su prisutni i grafiti.



Sl. 5 Primjer mrlje na mjestu s kojeg je odstranjen katranski premaz; lijevi polustup istočnog pogleda

Fig. 5 An example of a stain in a spot from where a layer of tar was removed; the left semi-column as seen from the east.

2.1.2. Biološki film

Iako bi ova vrsta degradacije mogla biti dijelom skupine koja se odnosi na vegetaciju i biološke patine, izdvojena je u cilju lakšeg prepoznavanja površina koje su njome zahvaćene.

Biološki film zastupljen je na velikim površinama spomenika. Radi se o tamnosivoj boji koju uzrokuju kolonije odumrlih lišajeva.

2.1.3. Crne inkrustacije

Svaki spomenik koji se nalazi u urbanoj sredini i izložen je atmosferskim utjecajima bit će s vremenom prekriven raznim nečistoćama koje će manje ili više prionuti uz kamenu površinu. Ovi su depoziti uglavnom sive do crne boje i obično se nalaze na mjestima koja su zaštićena od kiše. Ovakvi depoziti su u početku ravnomjerne strukture i samo potamniju zahvaćeno područje, ali s vremenom postaju sve deblji i kvrgaviji.

2.1. Stains, biological film and black incrustations

2.1.1. Stains

The stains on the Double Gate were in the vast majority of cases caused by tar, or were left there after the tar coating was removed. Initially it was thought that the fragments were reddish in color because of close contact with red earth; however, by comparing historical photographs, and after the discovery of the data put forth by Pons in Eco di Pola in 1887, it was concluded that these are tar stains. There are also sporadic instances of graffiti.



Sl. 6. Primjer grafita

Fig. 6 An example of graffiti.

2.1.2. Biological film

Although this kind of degradation could be included in the group dealing with vegetation and biological patinas, it was separated in order to facilitate the recognition of surfaces that were attacked by it.

Biological film is represented on large surfaces of the monument. It is a dark grey color caused by colonies of lichen that have died off.

Također, sve su tvrđi i manje porozni pa mehaničke i termičke karakteristike inkrustacije i kamena sve više gube na sličnosti. Primjerice, crna inkrustacija privlači mnogo više sunčeve topline od kamena pa ima veće vrijednosti termičkog širenja. Zbog različitih toplinskih koeficijenata sljedeća je faza pucanje crne inkrustacije pa ona otpada s kamene površine i oštećuje njen površinski sloj te se odmah počinje stvarati nova inkrustacija. Također, znatan je problem kod crnih inkrustacija prisutnost velike količine gipsa u poveznom sloju između inkrustacije i kamena. Konstantnim izmjenama vlažnih i suhih razdoblja gips prelazi u mikrofrakture i pore kamena. Osim toga, prilikom čišćenja crnih inkrustacija ovaj sloj gipsa ostaje vezan za kamenu podlogu i na njemu se uskoro počinje stvarati nova crna inkrustacija². Na pozicijama crnih inkrustacija može se očekivati i jača kontaminacija štetnim topivim solima: kloridima iz mora, sulfatima iz zagađene atmosfere, ali i iz mora, te topivim alkalijskim karbonatima iz cementa. U tom smislu treba provesti dijagnostička istraživanja (kemijske analize) i po potrebi adekvatne sanacijske zahvate vezane uz desalinizaciju.

Crne su inkrustacije također prisutne na svim dijelovima spomenika, posebno na onima koji su zaštićeni od kiše, što je i uobičajeno za ovu vrstu degradacije.



Sl. 8 Primjer crnih inkrustacija na Dvojnim vratima
Fig. 8 An example of black incrustations on the Double Gate.

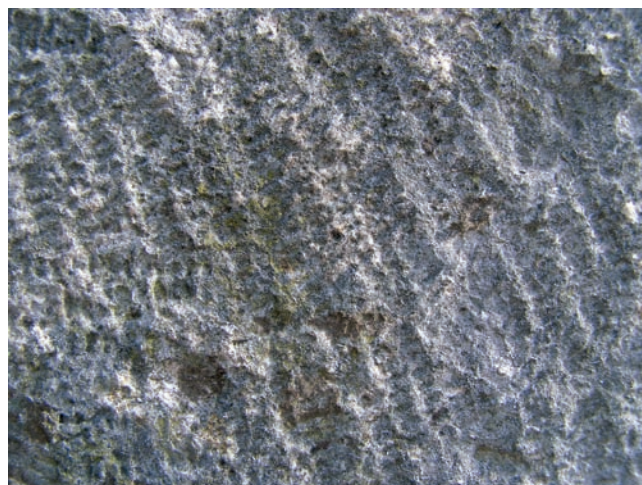
2.2. Vegetacija i aktivne biološke patine

2.2.1. Prisutnost vegetacije

U pukotinama, gdje se zbog vjetrova nakuplja prašina i zemlja, uz prisutnost vode razvija se i vegetacija.

Vegetacija je na spomeniku prisutna u velikom broju. Srećom, radi se o manjim biljkama, ali i one

² O djelovanju gipsa na kamen bolji i precizniji opis je u: Malinar, H., 2003. *Vlaga u povijesnim građevinama* (str. 26)



Sl. 7 Primjer biološkog filma i detalj
Fig. 7 An example of biological film and a detail.

2.1.3. Black incrustations

Every monument located in an urban environment and at the same time exposed to atmospheric influences will be covered with different dirt with the passage of time, which will stick more or less obstinately on the stone surface. These deposits are mainly in the color range from grey to black, and they are located predominantly in areas protected from rain. The structure of such deposits is initially even, only darkening the befallen area; however,

imaju negativan učinak na kamen. Iako ne postoji dokumentacija, autorica sa sigurnošću može potvrditi da je prije 3–4 godine iz pukotine na stražnjem dijelu centralnog pilastra rasla mala smokva, koja je mehanički odstranjena i ostaci korijenja tretirani su kemijskim preparatom. Korijen smokve širi se u fugama i pukotinama te može izazvati veću štetu.



Sl. 9 Primjer tipične vegetacije prisutne na Dvojnim vratima
Fig. 9 An example of typical vegetation present on the Double Gate.

2.2.2. Biološka patina

Za razliku od biološkog filma, za koji se pretpostavlja da se radi o površinama odumrlih slojeva lišajeva, biološku patinu predstavljaju slojevi aktivnih lišajeva i algi. Alge nisu direktna opasnost za opstanak kamene površine, ali čine podlogu za nastanak aktivnih kolonija lišajeva, koji toj površini štete. Svojim mikrokorijenjem stvaraju sitne rupice koje s vremenom postaju prava mreža povezanih i sve većih rupica u kamenu. Također, kisele tvari koje nastaju njihovim metabolizmom oštećuju površinu kamena topeći vapnenac. Kolonije lišajeva uzrokuju nepopravljive štete na kamenu i snižavaju njegovu površinu³.

Aktivne su biološke patine prisutne na ovom spomeniku i na nekim njegovim dijelovima prekrivaju velike površine. Iako ima i manjih količina algi, posebno u nižim dijelovima, gdje je konstantno prisutna vlaga, uglavnom su problematične žive kolonije lišajeva.

³ Poblježe u: Malinar, H., 2001. Štetni utjecaji lišaja na kamene spomenike kulture. *Klesarstvo i graditeljstvo*, 1–2, god. XII, 38–42, Pučišća

as time passes by they become thicker and more tuberous. They are likewise progressively harder and less porous, so that the mechanical and thermal characteristics of incrustations on one side and stone on the other gradually lose their similarities. For example, black incrustations attract much more heat from the sun in comparison with stone, which means that they have higher values of thermal spreading. Due to different thermal coefficients, the next phase is the breaking of the black incrustation that falls off from the stone surface, damaging thus its superficial layer, where a new incrustation begins to build immediately. Another problem associated with black incrustations is the presence of a large amount of gypsum in the binding layer between incrustation and stone. With constantly changing humid and dry periods, the gypsum enters into the micro-crevices and pores of the stone. Besides, when cleaning black incrustations this layer of gypsum remains bound to the stone surface, and a new black incrustation soon begins to develop on it². In positions contaminated with black incrustations we can also expect a large-scale contamination with harmful soluble salts: chlorides from the sea, sulphates from the polluted atmosphere and also from the sea, and soluble alkaline carbonates from cement. With this in mind, diagnostic research (chemical analyses) should be conducted, and if needed, a series of adequate improvement measures connected with desalinization should be performed.

Black incrustations are omnipresent on all parts of a monument, and especially on those that are protected from rain, which is customary for this kind of degradation.

2.2. Vegetation and active biological patinas

2.2.1. The presence of vegetation

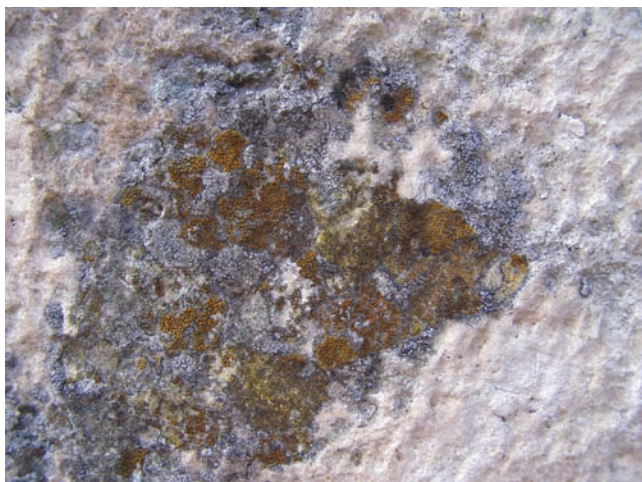
With the presence of water, vegetation develops in crevices that are filled with earth and dust brought there by the wind.

Vegetation is widely spread on the monument. Fortunately, we are talking about smaller plants, but they too have a negative effect on stone. Even though there is no available documentation, the author can confirm the existence of a small fig tree that grew out of a crevice in the posterior section of the central pilaster approximately 3–4 years ago; it was mechanically removed and its remaining roots were chemically treated. Fig tree roots widen in the crevices and they can cause major damage.

2.2.2. Biological patina

Unlike a biological film, which is supposed to be a surface of dead layers of lichens, a biological patina is made up of layers of active lichens and algae. Algae do not

² For a better and more precise description of the effects of gypsum on stone see: Malinar, H. 2003, *Vlaga u povijesnim građevinama (Humidity in historical buildings)*, p. 26.



Sl. 10 Primjer lišajeva prisutnih na Dvojnim vratima
Fig. 10 An example of lichens present on the Double Gate.

2.3. Alveolizacija, nedostajući dijelovi i pukotine

Ove vrste degradacija pripadaju strukturalnoj grupi te je njihovo saniranje od velikog značaja za očuvanje spomenika.

2.3.1. Alveolizacija

Alveolizacija je vid mehaničke degradacije, koja može nastati (i) uslijed djelovanja vjetra. Naime, vjetar nosi sitne kristale soli, koji ulaze u strukturu kamena te procesima topljenja i kristalizacije uzrokuju njegovo propadanje. Ova se degradacija uvijek vezuje uz poroznost kamena te njegove prirodno slabije točke, poput prisutnosti školjkaša ili prirodnih venatura. S obzirom na blizinu mora, kod Dvojnih vrata sigurna je prisutnost kristala soli donošanih vjetrovima, a moguće je i utjecaj soli u zemlji koja je stoljećima prekrivala spomenik. Djelovanjem vjetra koji nosi sitne čestice, na površini kamena nastaju milimetarske rupice, a kroz duže vremensko razdoblje stvaraju se prave rupe odnosno alveole, koje mogu biti široke i do nekoliko centimetara te isto toliko duboke. Alveole mogu biti i međusobno povezane.

Alveolizacijom su zahvaćene velike površine spomenika i uglavnom je uznapredovala pa su rupe promjera i do 10 cm. Njihova štetnost za strukturu spomenika može biti višestruka. One predstavljaju prostore u kojima se može nakupljati zemlja i voda te dovesti do razvoja vegetacije. Također, u njima se zimi može zalediti voda i tako prouzročiti pucanje kamena.

2.3.2. Nedostajući dijelovi

Nedostajućim dijelom označen je onaj koji se istrošio ili odlomio, odnosno kojeg više nema. Nedostajućih je dijelova mnogo. Kao što je i uobičajeno kod povijesnih

pose a direct threat to the survival of the stone surface, but they do form a base for the creation of active colonies of lichens that are harmful to the surface. With their micro-roots they create tiny holes that eventually become a real network of mutually connected and ever bigger holes in the stone. Likewise, the acidic substances that are created by their metabolism, damage the surface of the stone by melting the limestone. Colonies of lichens cause irreparable damage to the stone and lower its surface³.

The active biological patinas present on this monument and on some of its parts cover large surfaces. Although there are also smaller quantities of algae, especially in the lower sections where humidity is constantly present, the active colonies of lichens represent the main problem.

2.3. Alveolization, missing parts, and crevices

These types of degradations belong to the structural group; their improvement is of paramount importance for the preservation of the monument.

2.3.1. Alveolization

Alveolization is a form of mechanical degradation that may arise even due to wind action. In other words, the wind carries tiny salt crystals that enter into the stone structure, causing thus its degradation through various processes of melting and crystallization. This degradation is always connected with the porosity of stone and its natural weak points, such as the presence of shells or natural veins. With respect to the closeness of the sea, we can be sure that there are salt crystals present on the Double Gate, which had been brought there by the wind, and there is also the possibility that salt from the earth affects the monument that was buried in it for many centuries. Small holes that can be measured in millimeters appear on the stone surface due to the action of the wind that carries tiny particles. Over a longer period of time these holes become bigger, they become real holes or alveoles which can measure up to a few centimeters in width as well as in depth. Alveoles can also be mutually connected.

Alveolization has befallen large sections of the monument, and for the most part it has developed even further so that the holes can have a diameter of up to 10 centimeters. Their negative effects for the structure of the monument can be manifold. These holes represent areas for the deposition of earth and water, creating thus ideal conditions for the development of vegetation. And furthermore, water could freeze in them during winter, which would lead to the cracking of stone.

³ More details in: Malinar, H. 2001, Štetni utjecaji lišaja na kamene spomenike kulture (The harmful effects of lichens on cultural monuments made of stone). *Klesarstvo i graditeljstvo*, 1-2, god. XII, 38-42, Pučišća.

spomenika, uglavnom nedostaju uglovi i reljefna izbočenja, no na nekoliko mjesta praznine nastale odlamanjem kamenih ulomaka prodiru duboko u njegovu strukturu.

2.3.3. Pukotine

Mehanička puknuća često su dio degradacije povijesnih spomenika, a zabilježena su i na Dvojnim vratima, i to u velikom broju. Vizualnim pregledom nije moguće utvrditi dubinu pukotina, odnosno njihovu opasnost za statiku spomenika, no one u svakom slučaju predstavljaju bitnu degradaciju jer su u veću oštećenja. Kao i kod alveolizacije, u njima se može nakupiti prašina i voda te omogućiti razvoj vegetacije ili uzrokovati nastanak novih pukotina uslijed smrzavanja vode zimi.



Sl. 13 Primjer pukotine
Fig. 13 An example of a crevice.



Sl. 11 Primjer alveolizacije, izuzetno raširenog vida degradacije Dvojnih vrata
Fig. 11 An example of alveolization, a very widespread form of degradation on the Double Gate.

2.3.2. Missing parts

A missing part is one that had been worn out or else it had broken off and is missing. There are quite a few missing parts. As is commonly the case with historical monuments, mostly corners and protuberances in relief are missing; however, on several spots we can observe that the gaps created by the broken off fragments run deep into the structure of the monument.



Sl. 12 Primjer nedostajućih dijelova profilacije i ugaonog dijela kamenog bloka
Fig. 12 An example of missing parts in the form of decorative sections with a steplike profile, and a corner section of a stone block.

2.3.3. Crevices

Mechanical breakages are often among the degradations found on historical monuments; the Double Gate is no exception because many crevices were recorded there. A visual inspection does not suffice to determine the depth of a crevice, or the danger they pose for the structural stability of the monument. At any rate, crevices represent

2.4. Cementne ispune

Tijekom godina na Dvojnim vratima obavljena su razna “krpanja”, prilikom čega je korišten i cementni mort. Prvobitno je izgledalo da su neke ispune izrađene vapnenim mortom, koji bi bio dobar izbor za radove na kamenu zato što su nakon sušenja njegove tehničke karakteristike slične onima koje ima kamen, a u slučaju potrebe lako je odstranjiv. No, detaljnijim je uvidom utvrđeno da se vjerojatno radi o cementnim ispunama, koje su poprimile žuto-narančastu boju uslijed prekrivanja katranskim premazom. Tehničke karakteristike cementa, vezane uz elastičnost i termičko širenje, jako se razlikuju od karakteristika kamena. Također, cement se izuzetno čvrsto veže za kamen. Stoga se događa da se nakon određenog broja godina, tijekom kojih dolazi i do različitih mehaničkih pomaka kamena i cementa, potonji odvaja od kamene površine i otpada, ali budući da se čvrsto veže za kamen, “povuče” za sobom i njegov površinski sloj. Čak i da se cement ne odvoji sam od kamene površine, problem je što ga je u slučaju bilo kakve potrebe za radovima na spomeniku gotovo nemoguće odstraniti bez oštećenja površine kamena. Posljednji, ali ne manje važan problem jesu topive soli (natrijev i kalijev karbonat) koje su prisutne u cementu i koje s vremenom ulaze u strukturu kamena⁴.

Cementne su ispune i “zakrpe” na Dvojnim vratima mnogobrojne, na nekim su mjestima čak čitave površine prekrivene cementnim slojem. Vjerojatno je većina njih nastala prilikom restauracija spomenika tijekom 19. i početkom 20. stoljeća.



Sl. 14 Primjeri cementnih ispuna na Dvojnim vratima
Fig. 14 Examples of cement fillings on the Double Gate.

2.5. Metalni dijelovi

Tijekom povijesti spomenika, ponekad i prilikom same izgradnje, pojavljuje se potreba za učvršćivanjem

⁴ Poblježe o korištenju cementa u: Malinar, H., 1996. Negativna iskustva uporabe portland cementa pri restauriranju kamenih spomenika kulture. *Klesarstvo i graditeljstvo*, 1-2, 37-40, Pučišća

a major degradation as they serve as an introduction for major subsequent damages. As was the case with alveolization, they could harbor dust and water which in turn would result in vegetation, or else they could cause the creation of new crevices due to the freezing of water in wintertime.

2.4. Cement fillings

In the course of the years, numerous repair works were executed on the Double Gate, and for some of these works a cement mortar was employed. Originally it seemed as if though some of the fillings were done with calcareous mortar that would have been a good choice for use on stone because after it hardens, its technical characteristics are similar to those of stone, and if need arises it is easily removable. However, after a detailed analysis it was established that these are probably cement fillings that have become yellow-orange in color, as a consequence of the coating with tar. The technical characteristics of cement, as regards elasticity and thermal spreading, differ greatly from those of stone. Likewise important, cement adheres exceptionally well to stone. A consequence of this is that after a certain number of years, during which different mechanical shifts of both stone and cement occur, the latter separates itself from the stone surface and falls off, taking with it a superficial layer of stone because of its extraordinary adherence to stone. Even if the cement does not fall off from the stone surface by itself, the problem is that in case of any needed repair works on the monument, it is well-nigh impossible to remove the cement without damaging the surface of the stone. The last but by no means less important problem are the soluble salts (sodium and potassium carbonate) that are present in cement, which over a certain period of time enter into the structure of the stone⁴.

There are numerous cement fillings and “patches” on the Double Gate, in some areas there are whole surfaces that are covered with a layer of cement. Most of these were probably made during the restoration of the monument in the course of the 19th and at the beginning of the 20th century.

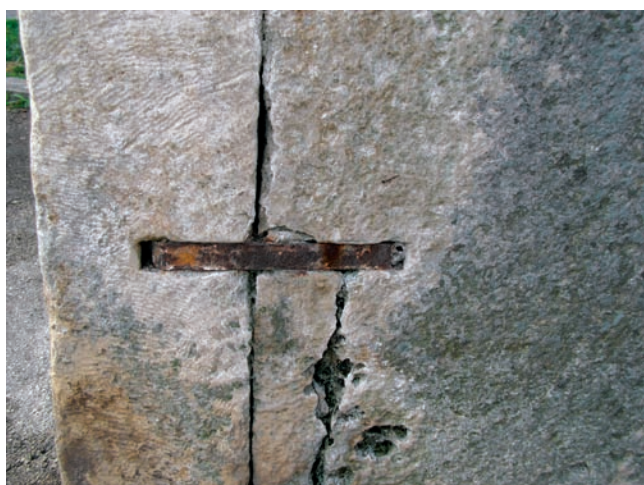
2.5. Metal parts

In the course of the life span of a monument, and sometimes even during its erection, there comes a time when it is necessary to strengthen parts of its structure. Mostly metal spikes and clamps were used for

⁴ More details about the use of cement in: Malinar, H. 1996, Negativna iskustva uporabe portland cementa pri restauriranju kamenih spomenika kulture (The negative experiences in conjunction with the use of portland cement for restoration of cultural monuments made of stone). *Klesarstvo i graditeljstvo*, 1-2, 37-40, Pučišća.

dijelova strukture. Najčešće su u tu svrhu korišteni metalni klinovi i poveznice. Ako se radi o nehrđajućim materijalima poput inoks čelika, ti klinovi ne predstavljaju problem. No, ako je riječ o željezu, što je najčešći slučaj, osim nastanka neestetskih mrlja crvenkastosmeđeg željeznog oksida, klinovi od tog materijala pod utjecajem vode i soli, odnosno atmosferskih prilika, oksidiraju i šire se, pri čemu se razvija visoki tlak i dolazi do puknuća kamena.

U manjem su broju na Dvojnim vratima prisutne željezne spojnice, koje su korištene pri povezivanju kamenih dijelova tijekom prošlih restauracija, a neke možda čak i u vrijeme izgradnje. Vidljivi su i ostaci željeznih nosača nekadašnjih metalnih vrata koja su zatvarala lukove spomenika. Usto, na mnogim su mjestima željezni čavli i klinovi, čija svrha nije jasna niti je moguće pretpostaviti u kojem su povijesnom periodu umetnuti u spomenik.



Sl. 16 Primjer (moguće originalne) željezne spojnice
Fig. 16 An example (possibly original) of an iron clamp.



Sl. 17 Primjer željeznog klina u strukturi spomenika
Fig. 17 An example of an iron spike in the structure of the monument.



Sl. 15 Primjeri cementnih ispuna na Dvojnim vratima
Fig. 15 Examples of cement fillings on the Double Gate.

this purpose. If these metal spikes were made of non-corroding materials such as stainless steel, they do not pose any problems. However, if they are made of iron, as is mostly the case, besides the creation of unaesthetic stains of reddish-brown iron oxide, spikes made of this material, under the influence of salt and water, and atmospheric elements, also oxidize and expand, creating thus a lot of pressure that causes the stone to crack.

There is only a small number of iron clamps on the Double Gate. These clamps were used to join together stone elements in past restorations, and some of them were probably used during the erection of the monument. Also visible are the remains of iron supports of the metal gates that closed the arches of the monument. On top of this, there are many iron nails and spikes, whose purpose is neither clear nor is it possible to presume in which historical period they were affixed to the monument.

3. A proposal for works

3.1. Documentation and analysis of the situation

To begin work on the Double Gate that is a cultural monument, it is certainly necessary to prepare and update the existing documentation. Specifically, the existing architectural drawings are outdated and many details are incorrect. To make the degradation charts, plans made by the City Office for Cadastre and Geodetic Activities from Zagreb were used, which had to be re-worked in order for them to match the present-day state of the monument. It would certainly be interesting to create a 3D image of the monument, but what is needed most are plans and cross-sections of the existing situation in the appropriate scale. Specifically for this type of monument, a transverse cross-section should be made, with a view of the vaults of the arches. It would also be desirable to include in these new plans the degradation charts that have been compiled during 2010 or later.

3. Prijedlog za radove

3.1. Dokumentacija i analiza stanja

Za početak radova na Dvojnim vratima, spomeniku kulture, svakako je potrebno izraditi i obnoviti postojeću dokumentaciju. Naime, postojeći arhitektonski nacrti zastarjeli su i u mnogim detaljima netočni. Za potrebe izrade degradacijskih karata korišteni su nacrti Zavoda za katastar i geodetske poslove grada Zagreba, koji su prerađeni ne bi li odgovarali realnom stanju spomenika. Svakako bi bilo zanimljivo izraditi 3D snimku spomenika, ali ono što je najpotrebnije jesu nacrti i presjeci postojećeg stanja u prikladnom mjerilu. Specifično za ovakvu vrstu spomenika trebalo bi izraditi i poprečni presjek, s pogledom na svodove lukova. Također bi bilo poželjno nove nacрте popuniti degradacijskim kartama koje su izrađene tijekom 2010. godine ili novijima.

S ciljem uvida u strukturalno stanje spomenika, trebalo bi načiniti nekoliko različitih testova i analiza.

- termografskim snimanjem moguće je ustanoviti prisutnost šupljina unutar kamene strukture
- magnetometrijskim testom moguće je locirati željezne dijelove unutar kamene strukture
- ultrazvučnom metodom moguće je mjeriti dubinu pukotina te procijeniti mehaničke karakteristike kamena (čvrstoću i elastični modul)
- dinamičkim testom akcelerometrima moguće je analizirati strukturalno ponašanje spomenika u prisutnosti dinamičkih podražaja poput vjetrova, prometa, potresa; ovaj je test možda najvažniji za poznavanje statičke stabilnosti spomenika, iako sam spomenik ne pokazuje statičku nestabilnost

Ovi testovi nisu destruktivni, no zbog kvalitetnijeg uvida u stanje spomenika bilo bi poželjno učiniti i nekoliko testova za koje treba uzeti uzorke kamenog materijala spomenika i uzorke zabilježenih degradacija. To su:

- petrografska analiza vrste kamena – u ovom bi slučaju bilo korisno analizirati originalni kamen spomenika i barem jedan uzorak naknadne nadogradnje
- definiranje osnovnih parametara kamenog materijala: poroznost i vrsta poroznosti (otvorena ili zatvorena), mehaničke karakteristike kamena
- kvantitativne kemijske analize soli prisutnih unutar kamene strukture i na površini kamena
- analiza poprečnog mikropresjeka i površine kamena, ne bi li se dobio uvid u površinsko stanje kamenog materijala te tako nakon izvedenih radova mogao vidjeti utjecaj koji su zahvati imali na kamenu
- izrada mikropresjeka cementnih ispuna i premaza

In order to inspect the structural condition of the monument, it is necessary to make different tests and analyses.

- With thermographic imaging it is possible to determine the presence of cavities within the stone structure.
- With a magnetometric test it is possible to detect iron parts within the stone structure.
- Using the ultrasound method it is possible to measure the depth of the crevices and to gauge the mechanic characteristics of stone (hardness and elastic module).
- With a dynamic test on an accelerometer it is possible to analyze the structural behavior of the monument in the presence of dynamic irritants such as wind, traffic, or an earthquake; this is perhaps the most important test to get to know the static stability of the monument, even though the monument itself shows no signs of static instability.

These tests are by no means destructive; however, to get a better insight into the state of the monument it would be desirable to perform several tests that necessitate the taking of stone material samples from the monument, as well as samples of the recorded degradations. They are:

- A petrographic analysis of the type of stone – in this case it would be useful to analyze the original stone from the monument and at least one sample from a subsequent addition.
- A definition of the basic parameters of the stone material: porosity and type of porosity (open or closed), and the mechanical characteristics of stone.
- Quantitative chemical analyses of salts present within the stone structure and on the surface of the stone.
- An analysis of the transverse micro-cross-section and surface of the stone, in order to get an insight into the state in which the surface of the stone material is in and, after the works had been completed, to observe how the works influenced the stone.
- Micro-cross-sections of the cement fillings and coatings.
- An analysis of the cross-section of the surface befallen with gray and active lichens.
- An analysis of the cross-section of the surface befallen with black incrustation, together with a chemical analysis of the incrustation.

Bearing in mind that these suggestions only have an introductory character, we do not define the sampling areas. They should be determined, though, by a careful comparison between the existing degradations and other fringe occurrences that influence these degradations, in order to interconnect the thus obtained data and use the results to plan future conservation-restoration works.

- analiza presjeka površine zahvaćene sivim i aktivnim lišajevima
- analiza presjeka površine zahvaćene crnom inkrustacijom, uz kemijsku analizu inkrustacije

S obzirom da su ovi prijedlozi tek uvodnog karaktera, ne definiraju se mjesta uzorkovanja. Ona bi se trebala odrediti pažljivom usporedbom postojećih degradacija i okolnih pojava koje na degradacije utječu, ne bi li se dobiveni podaci mogli kvalitetno povezati s planiranjem budućih konzervatorsko-restauratorskih zahvata.

3.2. Konzervatorsko-restauratorski zahvati

Konzervatorsko-restauratorski zahvati koje bi trebalo planirati za ovaj spomenik jesu čišćenje, odstranjivanje štetnih soli akumuliranih na površini i pod površinom kamena, učvršćivanje pukotina, lijepljenje ulomaka i vraćanje odstranjenog dijela, uklanjanje vegetacije i bioloških kolonija te konsolidacijski i zaštitni premazi. Svakako je bitno naglasiti da prije početka radova treba provesti testove čišćenja, konsolidacije i zaštitnog premaza, da bi se utvrdile metode i proizvodi koji najbolje odgovaraju vrsti kamena i spomenika.

3.2.1. Čišćenje

Početni bi radovi trebali biti čišćenje površina, pri čemu treba slijediti nekoliko osnovnih restauratorskih načela za takve zahvate na spomenicima kulture:

- postupak čišćenja treba biti moguće kontrolirati u svakom trenutku, a on sam valja biti selektivan – njime se smije odstraniti isključivo ono što se namjerava očistiti s kamena, bez oštećenja njegove “epiderme”
- ne smije stvarati tvari koje su štetne za spomenik ili onemogućavaju njegovu pravilnu konzervaciju (npr. topive soli)
- ne smije ni na koji način uzrokovati oštećenje površine kamena (abrazije, ogrebotine alatom, mikropukotine ili bilo kakve modifikacije koje bi pridonijele nastanku novih degradacija)

Čišćenje spomenika podrazumijeva nekoliko različito usmjerenih zahvata: čišćenje kamene površine (odstranjivanje odumrlih kolonija lišajeva, crnih inkrustacija i mrlja), odstranjivanje živućih kolonija algi i lišajeva, cementnih nadogradnji te metalnih klinova.

Slijedi opis zahvata čišćenja u redoslijedu kojim bi trebali biti izvedeni.

a) Kolonije odumrlih lišajeva mogu se u najvećoj mjeri odstraniti pranjem mlazom vode pod tlakom, bez korištenja abraziva. Crne vrste lišaja teško je odstraniti samo mlazom vode pa je uz odgovarajući oprez moguće upotrijebiti fine, već iskušane abrazive.

3.2. Conservation-restoration works

The conservation-restoration works that should be planned for this monument are cleansing, removal of harmful salts that accumulated on the surface and underneath the surface of the stone, reinforcement of crevices, bonding of fragments and renewed installation of removed parts, removal of vegetation and biological colonies, and the application of consolidating as well as protective coatings. Of course that it is necessary to stress that prior to the beginning of the works, a series of cleansing, consolidation and protective coating tests should be performed, in order to determine the methods and products that best suit this type of stone and monument.

3.2.1. Cleansing

The initial works should consist of surface cleansing, during the execution of which we should follow several restoration principles dealing with such interventions on cultural heritage monuments:

- We should be able to control the cleansing procedure at all times, and the procedure itself should be selective – only what is intended to be cleansed away from the stone should be removed with it, without damaging its “epidermis”.
- It should not create substances that are harmful to the monument, or those that preclude its correct conservation (e.g., soluble salts).
- It should not in any way cause damages on the surface of the stone (abrasion, scratches made by tools, micro-cracks, or other modifications that would result in new degradations).

The cleansing of the monument implicitly includes several differently oriented interventions: cleansing of the stone surface (removal of died-off colonies of lichens, black incrustations and stains), removal of living colonies of algae and lichens, of cement-made additions, and metal spikes.

A description of the necessary cleansing interventions follows in the sequence in which they should be executed.

a) The colonies of dead lichens can be for the most part removed by pressure washers, without any use of abrasives. Black lichens, on the other hand, are hard to remove by pressure washers only, which means that with the necessary caution it is possible to use fine, already tested abrasives.

b) Several methods can be used for the removal of black incrustations.

- Mechanical cleansing that includes the use of small palette knives, scalpels and dental micro-drills with various bores and brushes. This method is extremely slow and depends on the restorer’s hand. However, it may be helpful in order to thin the extraordinarily

b) Za odstranjivanje crnih inkrustacija moguće je koristiti raznovrsne metode.

- Mehaničko čišćenje, koje podrazumijeva korištenje špahtlica, skalpela i zubarskih mikrobušilica s raznim svrdlima i četkicama. Ova je metoda izuzetno spora i ovisi o ruci restauratora. No, može biti korisna da bi se stanjili izuzetno debeli slojevi inkrustacije, ako se pažljivo koriste čekić i dljetlo. Kod čišćenja mlazom abraziva, u slučaju debljih kora počinje se nešto oštrijim granulatom, a idući prema "epidermi" treba preći na najfiniji abraziv. Kod suhog čišćenja abraziv je pokretan stlačenim zrakom, a kod mokrog mlazom vode.
- Čišćenje atomiziranom vodom. Aparati, atomizatori, pretvaraju vodu u izuzetno sitne čestice koje u odnosu na običnu vodu imaju mnogo veću sposobnost natapanja. Tako dubinski natopljene inkrustacije omekšaju i lako se odstranjuju. Metoda je još učinkovitija ako se koristi deionizirana voda.
- Ultrazvučno čišćenje. Koristeći zubarske ultrazvučne aparate moguće je odstraniti i vrlo debele inkrustacije s površine kamena, ali površina ne smije biti degradirana jer bi u tom slučaju inkrustacija za sobom povukla i dio originalnog materijala. Nedostatak ove metode je sporost, ali i moguća degradiranost kamena ispod inkrustacije, pri čemu bi korištenje ultrazvučne metode moglo uzrokovati otpadanje kamenih ljuski.
- Čišćenje glinama. Sepiolit i atapulgit su gline koje se uglavnom koriste pri čišćenju od crnih inkrustacija. Bezopasne su, s obzirom da je glavni agens čišćenja deionizirana voda. Njihov je problem što su učinkovite samo kod tankih crnih inkrustacija i što nije moguće nadzirati proces dok traje.
- Čišćenje komercijalnim pastama. Ova je metoda učinkovitija kod manjih inkrustacija, ali njena opasnost leži u prisutnosti soli u pastama. Stoga je od velike važnosti nakon procesa čišćenja posvetiti pozornost dobrom ispiranju površine.
- Korištenje lasera optimalno rješava sve probleme koji se vezuju uz proces čišćenja. Ova metoda ne ostavlja štetne tvari u kamenu, omogućava čišćenje degradiranih površina i teško dostupnih mjesta, a i, što je najvažnije, moguće ju je kontrolirati u svakom trenutku jer su rezultati rada odmah vidljivi. Također, laserom bi se mogle očistiti smeđe mrlje od zemlje, no vjerojatno ne u potpunosti, s obzirom da crveni pigment iz zemlje prodire i u samu strukturu vapnenca. Ipak, nakon čišćenja predstavljale bi manji estetski problem. Osnovni je problem kod lasera njegova cijena i izuzetno sporo napredovanje radova.

thick layers of incrustation, if a hammer and chisel are carefully used. When cleansing with an abrasive jet machine, in case of thicker crusts, we begin by using a somewhat coarser granulate, gradually changing to the finest abrasive as we approach the "epidermis". In the dry cleaning procedure, the abrasive is driven by compressed air, while in the wet variant it is driven by a water jet.

- Cleansing by atomized water. The atomizers convert water into extremely tiny particles that have a much greater capability of soaking with respect to water. In this way deep-soaked incrustations soften and are easily removable. The method becomes even more efficient if deionized water is used.
- Cleansing by ultrasound. It is possible to remove very thick incrustations from the surface of stone by using dental ultrasound apparatuses; however, the surface should not be degraded as in that case the incrustation would also take with it a part of the original material. Some of the shortcomings of this method are that it is slow, and then there is the possible degradation of stone underneath the incrustation, because the usage of the ultrasound method could cause stone husks to fall off.
- Cleansing with clays. Sepiolite and atalpigite are clays that are mainly used to clean black incrustations from stone. They are harmless as the main cleansing agent is deionized water. Some of the problems they pose are that they are effective only with thin black incrustations, and that it is not possible to control the process while it lasts.
- Cleansing with commercial pastes. This method is more efficient with smaller incrustations; however, it is dangerous inasmuch these pastes contain salts. It is therefore imperative to give the treated surfaces a good rinse after the process of cleansing.
- The use of a laser is an optimal solution for all problems associated with the cleaning process. This method leaves no harmful substances in the stone, and facilitates the cleaning of degraded surfaces and areas that are difficult to access; most important of all, however, is that it is easily controllable at all times as the results of the treatment are visible at once. A laser could also be used to clean the brown stains caused by earth, probably only partially though, because the red pigment from the earth enters into the structure of the limestone itself. Nonetheless, after cleansing, these stains would become a much smaller aesthetical problem. The main problem associated with lasers is their hefty price tag and the very slow progress of works.

c) Uz uklanjanje nečistoća i crnih inkrustacija trebalo bi provesti tretman odstranjivanja živih bioloških organizama, odnosno algi, lišajeva i biljaka. Za alge i lišajeve kvalitetnima su se pokazali proizvodi na bazi alkil-dimetil-benzil amonijeva klorida. Koriste se u vodenoj otopini od 1 do 3%. Nakon primjene važno je tretirano mjesto dobro isprati, da se uklone ostaci kemikalija, posebno klorida. Za uklanjanje vegetacije preporučeni su proizvodi na bazi metoksitriazina, koji djeluju i na korijenje i na lišće. Nakon primjene sredstva potrebno je čekati 60 dana da bi se biljka u potpunosti osušila te se tada odstranjuje. Potom valja ukloniti i zemlju koja se nalazi u utorima kamena.

d) Ako kvantitativne kemijske analize razine topivih soli u kamenu pokažu veću koncentraciju od dozvoljene, obavezno se pristupa desalinizaciji. Najveći udio natrijevog klorida isprat će se vodom, a eventualne zaostale kloride treba eliminirati aplikacijama celulozne pulpe, uz odgovarajuću kontrolu uz pomoć kvantitativnih kemijskih analiza. Ako se ovim metodama ne odstrani u potpunosti kalcijev sulfat u dubini kamena, moguće je pristupiti kemijskim metodama desulfatizacije.

e) Odstranjivanje starih cementnih ispuna i nadogradnji može se izvesti isključivo mehaničkim postupcima. Pažljivim korištenjem bušilice, dlijeta i skalpela polako se uklanjaju ispune dok se ne dođe do originalnog kamenog materijala.

f) Odstranjivanje metalnih klinova također je moguće izvesti isključivo mehaničkim postupcima, korištenjem bušilice, dlijeta i skalpela.

3.2.2. Mehaničko učvršćivanje i kemijska konsolidacija kamena

Pojam učvršćivanja odnosi se na lijepljenje ulomaka koji su se u potpunosti odvojili od tijela spomenika te na ispunjavanje pukotina i praznina. Konsolidacija obuhvaća zahvate ispunjavanja mikropukotina i pora kamena te vraćanje originalne kompaktnosti kamenu, što usporava daljnje procese degradacije.

Za lijepljenje kamenih ulomaka višegodišnja je učinkovita praksa korištenje epoksidnih smola. Ako postoji potreba - zbog veličine - odlomljene ulomke treba učvrstiti spojnicama, uglavnom od inoksa, a u novije se vrijeme koriste i spojnice od titana.

Sljedeći je korak ispunjavanje pukotina i praznina (injektiranje). Ako je utvrđeno da su pukotine problematične po statiku spomenika, valja ih učvrstiti, a u tom slučaju treba u strukturu spomenika unijeti moderne materijale u vidu spojnica. No, vizualnim pregledom spomenika ne čini se da će postojati potreba za takvom vrstom zahvata. Teoretski, trebalo

c) Along with the removal of dirt and black incrustations, we should also eliminate the living biological organisms, i.e., algae, lichens and plants. Products based on alkyl-dimethyl-benzyl ammonium chloride have proven themselves effective in combating algae and lichens. They are used in a 1 to 3% water solution. After treatment, it is important to rinse well the area where they were used, in order to remove all traces of chemicals, especially chloride. Products based on metoxytriazine are recommended for the removal of vegetation, as they affect both leaves and roots. After the chemical was applied it is necessary to wait 60 days for the plant to die off completely, and only then it is removed. The earth from the grooves in the stone should likewise be subsequently removed.

d) If quantitative chemical analyses of the level of soluble salts in the stone show a concentration that is higher than the allowed one, we should obligatorily carry out a process of desalinization. The biggest share of sodium chloride will be rinsed away with water; eventual chloride residues should be eliminated with applications of cellulose pulp, along with an adequate control with the help of quantitative chemical analyses. If with these methods we cannot completely remove the calcium sulfate located deep in the stone, we can begin to desulphate with chemical methods.

e) The removal of old cement-made fillings and additions can be achieved with mechanical means only. By carefully using drilling machines, chisels and scalpels, we slowly remove these fillings until we reach the original stone material.

f) The removal of metal spikes is possible only through mechanical means, using drilling machines, chisels and scalpels.

3.2.2. Mechanical reinforcement and chemical consolidation of stone

The notion of reinforcement applies to the bonding of fragments that have severed themselves completely from the body of the monument, and to the filling of crevices and voids. Consolidation on the other hand encompasses interventions such as the filling of micro-crevices and pores in the stone, and interventions designed to return the original compactness to the stone, all of which slows the subsequent processes of degradation.

Epoxy resin used for bonding of stone fragments has over the years proven to be very effective. If it is needed, on account of size, the broken off fragments should be fastened by iron clamps, mainly made of stainless steel, although titanium ones were also used in recent times.

The next step is the filling of crevices and voids (injection). If it is determined that these cracks and crevices are problematic with respect to the statics of the monument, they should be reinforced. It is here that

bi ispuniti svaku pa i najmanju pukotinu, jer je svaka od njih zapravo oslabljeno mjesto. U pukotine može ući voda, koja u periodima smrzavanja uzrokuje njihovo povećavanje te može dovesti i do ozbiljnih problema vezanih uz statiku spomenika ili do odlamanja čitavih dijelova kamena. Također, u pukotine ulazi prašina, koja s vremenom postaje plodnim tlom za razvoj biljaka.

Ipak, zahvati ispunjavanja često su predmetom diskusija. Dok ih jedni zastupaju, zbog strukturalne zaštite spomenika, drugi im se protive zato što se njima unosi strani materijal u originalnu strukturu. Obje strane iznose realne stavove koje je moguće primijeniti na sam spomenik. Stoga se zahvati ne obavljaju na način da apsolutno svaka praznina bude ispunjena, već se odabiru dijelovi kojima prijete propadanje ako se ispunjavanje ne obavi. Kod Dvojnih vrata odluku o tome na kojim dijelovima obaviti ovaj zahvat valjalo bi donijeti tek nakon čišćenja, nakon potpunijeg uvida u situaciju.

Pod prazninama podrazumijevaju se, naravno, i alveole. Kod ove vrste degradacije uvijek se naglašava problem estetike, odnosno kako će alveole izgledati nakon ispunjavanja. Ne bi li se očuvao izgled površine kamena, općenito je prihvaćena praksa da se ispuna spusti nekoliko milimetara u odnosu na razinu originalnog kamena. Na taj su način sve alveole vidljive, ali nisu više opasne za strukturu kamena.

Za potrebe ispunjavanja većih pukotina koristi se vezivo u koje se u određenom omjeru dodaje kruti dio. Omjer veziva i krutog dijela utječe na poroznost, mehaničke karakteristike, stezanje prilikom sušenja i estetske karakteristike ispunje, stoga je bitno obaviti nekoliko testova te pronaći omjer koji najbolje odgovara konkretnom spomeniku. Kod vapnenca je moguće koristiti organska ili anorganska veziva. Organska su veziva najčešće akrilne ili epoksidne smole, a anorganska vapno ili vapno s dodatkom pucolana, radi postizavanja hidrauličkih svojstava (hidraulično vapno). Kao kruti dio koristi se prah iste vrste kamena, u koji se eventualno mogu dodati manje količine stabilnih pigmenta (poput zemljanih), ne bi li se dobio željeni ton boje sličan onome kamena spomenika.

Kod korištenja vapna kao veziva bitno je naglasiti da ispunje izrađene običnim vapnom nemaju dobre mehaničke karakteristike ni karakteristike trajnosti. Stoga je svakako poželjnije koristiti hidraulično vapno, posebno kod ispunjavanja pukotina bitnih za strukturalnu stabilnost i statiku spomenika.

Što se tiče organskih veziva, akrilne smole nemaju dobre karakteristike po pitanju statičke izdržljivosti. Ako je riječ o pukotinama koje mogu ugroziti strukturalnu stabilnost spomenika, poželjno je koristiti epoksidne

modern materials in the form of clamps are introduced into the structure of the monument. However, after a visual inspection of the monument it seems that such an intervention will not be needed. Theoretically, every crevice should be filled, however small, as each one of them in actual fact represents a weakened spot of the monument. Water can enter into cracks, and when freezing occurs these cracks expand, all of which can lead to serious problems in conjunction with the statics of the monument, or, this could also result in whole sections of stone breaking off. Dust also settles in these crevices and with the passage of time this becomes fertile ground for the growth of plants.

Nonetheless, filling interventions are often the subject of discussions. While some defend them because of the structural protection of the monument, others oppose them because they entail the introduction of foreign materials into the original structure. Both sides take a stand that is real and that could be applied to the monument itself. Consequently, the intervention does not consist of filling absolutely every crack and crevice, but rather, certain parts are selected which are in danger of being ruined if the filling is not carried out. As far as the Double Gate is concerned, we should decide on the parts that need such an intervention only after a thorough cleaning, after a more comprehensive inspection of the monument is carried out.

Alveoles are, naturally, also regarded as voids. Aesthetics are the primary concern with this type of degradation, i.e., how the alveoles will appear after the filling. In order to preserve the appearance of the stone surface, it is generally accepted practice to lower the filling a few millimeters in relation to the original level of the stone. In this way all the alveoles are visible, but they are no longer dangerous to the structure of the stone.

When filling larger crevices, we use a binder mixed with a solid component in a certain ratio. The ratio between the binder and the solid part influences porosity, mechanical properties, the setting during the drying period, and the aesthetic characteristics of the filling, and that is why we should perform a few tests in order to find a ratio that best suits a specific monument. When dealing with limestone we can use organic or inorganic binders. Organic binders are usually acrylic or epoxy resins, and inorganic ones are lime or lime with the addition of pozzolan in order to achieve hydraulic properties (hydraulic lime). The solid part usually consists of powder from the same type of stone, into which we can eventually admix smaller quantities of stable pigments (like earth pigments), in order to obtain the desired color tone that is similar to the stone of the monument.

When using lime as binder it is important to stress that fillings made with common lime do not have good mechanical characteristics or durability. It is therefore

smole niskog viskoziteta za dubinsko ispunjavanje, a akrilne smole otopljene u organskom otapalu (koje su stabilnije na svjetlu) za površinski dio pukotine. Pri injektiranju se mogu koristiti uređaji za postizanje povišenog tlaka, ne bi li se osiguralo dubinsko prodiranje sredstva.

Konsolidacija se izvodi na kamenu vrlo oslabljene strukture (povećan porni prostor, pojava mreže mikropukotina, površinska izluskanost kamena). Kod ovakvih problema epoksidne i akrilne smole imaju prevelike molekule i ne mogu penetrirati u strukturu kamena. Tada se koriste sredstva koja imaju mogućnost prodrijeti u strukturu te vratiti gotovo originalnu kompaktnost kamenu.

3.2.3. Nadogradnja nedostajućih dijelova

Nadogradnje nedostajućih dijelova mogu se podijeliti u dvije kategorije - estetske i one kojima je svrha očuvanje spomenika.

Iako kod Dvojnih vrata nedostaju dekorativni elementi poput profilacija, osobno je mišljenje autorice da ne postoji potreba za njihovom nadogradnjom. Istrošenost profilacija dokaz je zuba vremena odnosno originalnosti i starosti samog spomenika.

Drugačija je situacija kod nekoliko dijelova čije pomanjkanje otvara put prodiranju vode i nastajanju novih degradacija. Na takvim je mjestima nadogradnja poželjna. Moguće je birati između potpuno umjetne nadogradnje komercijalnim materijalima koji nakon sušenja izgledaju poput kamena ili nadogradnje novim kamenim umetkom isklesanim na način da se što bolje prilagodi praznini (kameni tašel) te ugradi uz pomoć vapnene žbuke i/ili epoksidnih ljepila.

3.2.4. Završna zaštita

Građevine od vapnenca tijekom godina dobivaju zaštitnu patinu koja smanjuje štetne utjecaje i usporava degradaciju kamena. To su dvije modifikacije kalcijeva oksalata: vevelit i vedelit (whewellite i weddellite). No, površine koje su dugo vremena bile prekrivene raznovrsnim taloženjima koje kamenu štete (crne inkrustacije, biološke kolonije), nakon čišćenja konzervatorsko-restauratorskim zahvatima često više nemaju zaštitnu patinu pa im je potrebno pomoći da bi se usporilo djelovanje okoline u smislu nastanka novih degradacija.

U tu se svrhu uglavnom koriste razna hidrofobna sredstva (bazirana na fluoru, silikonu ili siloksanu), koja sprječavaju prodor vode (i s vodom topivih soli koje se prenose zrakom) u spomenik, a istovremeno dozvoljavaju propuštanje pare. Postoje i kombinirana sredstva, koja

desirable to use hydraulic lime, especially when filling crevices that are vital for the structural stability and statics of the monument.

As far as organic binders are concerned, acrylic resins do not possess satisfactory characteristics regarding static endurance. If we are dealing with cracks that can put in jeopardy the structural stability of a monument, it is desirable to use epoxy resins with a low level viscosity for depth fillings, and acrylic resins dissolved in an organic solvent (which are more stable when exposed to light) for the superficial part of the crack. When injecting, we can use appliances that work under pressure, in order to make sure that the binder goes as deep as necessary.

Consolidation is performed on stone whose structure has been considerably weakened (an increased porous area, the appearance of a whole network of micro-crevices, the superficial flakiness of stone). When faced with problems like this, we should remember that epoxy and acrylic resins have molecules that are too big to penetrate into the structure of the stone. For such purposes we use substances that are capable to penetrate into the structure of the stone, and to return an almost original compactness to it.

3.2.3. Subsequent addition of missing parts

The subsequent additions of missing parts can be divided into two categories - the aesthetical ones and those whose goal is the preservation of the monument.

Although there many decorative elements that are missing on the Double Gate, the personal opinion of the author is that there is no need to add them subsequently. The worn out state of these decorations stems from the passage of time, and it is proof of the monument's originality and age.

The situation is totally different if water is allowed to penetrate into the monument, or if there are further degradations because some parts are missing. In places like this it is desirable to erect the missing parts. We can choose between an addition made of wholly artificial, commercially available materials that after setting and drying look like stone, or, we can make this missing part out of stone, hewn in the best possible manner in order to resemble the rest of the monument (a subsequent addition made of stone), which is then installed into the monument with the help of calcareous mortar and/or epoxy glues.

3.2.4. Final protection

With the passage of years, structures made of limestone obtain a protective patina that diminishes harmful effects and slows down the degradation of stone. These are two modifications of calcium oxalate: whewellite and weddellite. However, surfaces that had been covered for a long time with sedimentations that are harmful to the stone (black incrustations, biological colonies), after cleansing with the help of conservation-restoration interventions, often lose their protective patina, and so it

osim što imaju hidropelentne karakteristike štite spomenik i od vandalizma, poput ispisivanja grafita. Bitno je naglasiti da jednokratna primjena ovih sredstava nije solucija koja će spomenik dugotrajno zaštititi, već je potrebna njihova redovita primjena otprilike svakih 10 godina.

4. Monitoring

Nakon samih konzervatorsko-restauratorskih zahvata bitno je ne zaboraviti na spomenik niti smatrati da je njihovim okončanjem ova problematika zauvijek riješena. Praćenje stanja spomenika (monitoring) jednake je važnosti za njegovo očuvanje kao i prethodnih zahvati.

Spomenik valja redovito obilaziti, pratiti njegovo stanje te sustavno bilježiti sve primijećene promjene. Na taj je način moguće pravovremeno reagirati i zaustaviti ili ublažiti nastanak degradacija.

Redovitim praćenjem stanja spomenika on ne pada u zaborav i dobiva svoje vrijedno mjesto kao kulturno dobro, simbol povijesti.

5. Zaključak

Ne bi li se prikazalo stanje Dvojnih vrata, pažljivo su promatrani svi dijelovi spomenika. Zabilježene su i na tematskim nacrtima mapirane sve zamijećene degradacije. Odlučeno je da će se koristiti boje (nasuprot normiranom grafičkom sistemu obilježavanja) za obilježavanje degradacija, ne bi li ih se jače istaknulo kad mapirani nacrti postanu dijelom članka. Prijedlozi budućih aktivnosti i mogućih zahvata tek su informativnog karaktera, ali jasno ukazuju na potrebe spomenika i eventualni vremenski redoslijed zahvata. Neovisno o nastavku aktivnosti i radova, od velike je važnosti postojanje grafičke, pisane i fotodokumentacije o realnom stanju ovog antičkog spomenika u 2010. godini.

is necessary to help them to slow down the effects of the environment, the final goal being to lessen the creation of new degradations.

For this purpose, we generally use a variety of hydrophobic agents (based on fluorine, silicone or siloxane) that prevent the penetration of water (and water-soluble salts that are transmitted through the air) into the monument, while at the same time allowing the passage of water vapors. There are also combined agents that at the same time protect the monument against vandalism, like graffiti, besides having hydrorepellent characteristics. It should be noted that a single application of these agents does not represent a solution that will give a lasting protection to the monument. The treatment with these agents should be repeated in intervals of approximately 10 years.

4. Monitoring

After the completion of conservation-restoration works it is important not to forget the monument, nor to consider that these issues had been resolved forever. The monitoring of the monument is equally important for its conservation as were the previous interventions.

The monument should be inspected on a regular basis, its condition should be monitored, and all observed changes systematically recorded. In this way it is possible to react on time in order to stop or lessen the creation of degradations.

Regular monitoring of the monument prevents it from falling into oblivion. The monument thus takes its valuable position as part of the cultural heritage, and a symbol of history.

5. Conclusion

In order to show the state of the Double Gate, we carefully inspected all the sections of the monument. The observed degradations were recorded and mapped out on thematic charts. We decided to use color to mark all the degradations (as opposed to the standardized system of graphical marking), in order to further accentuate them when these mapped plans become part of the article. The expressed suggestions for future activities and possible interventions are only informative, but they nonetheless clearly indicate what needs to be done with this monument, and offer an eventual timeline for these interventions.

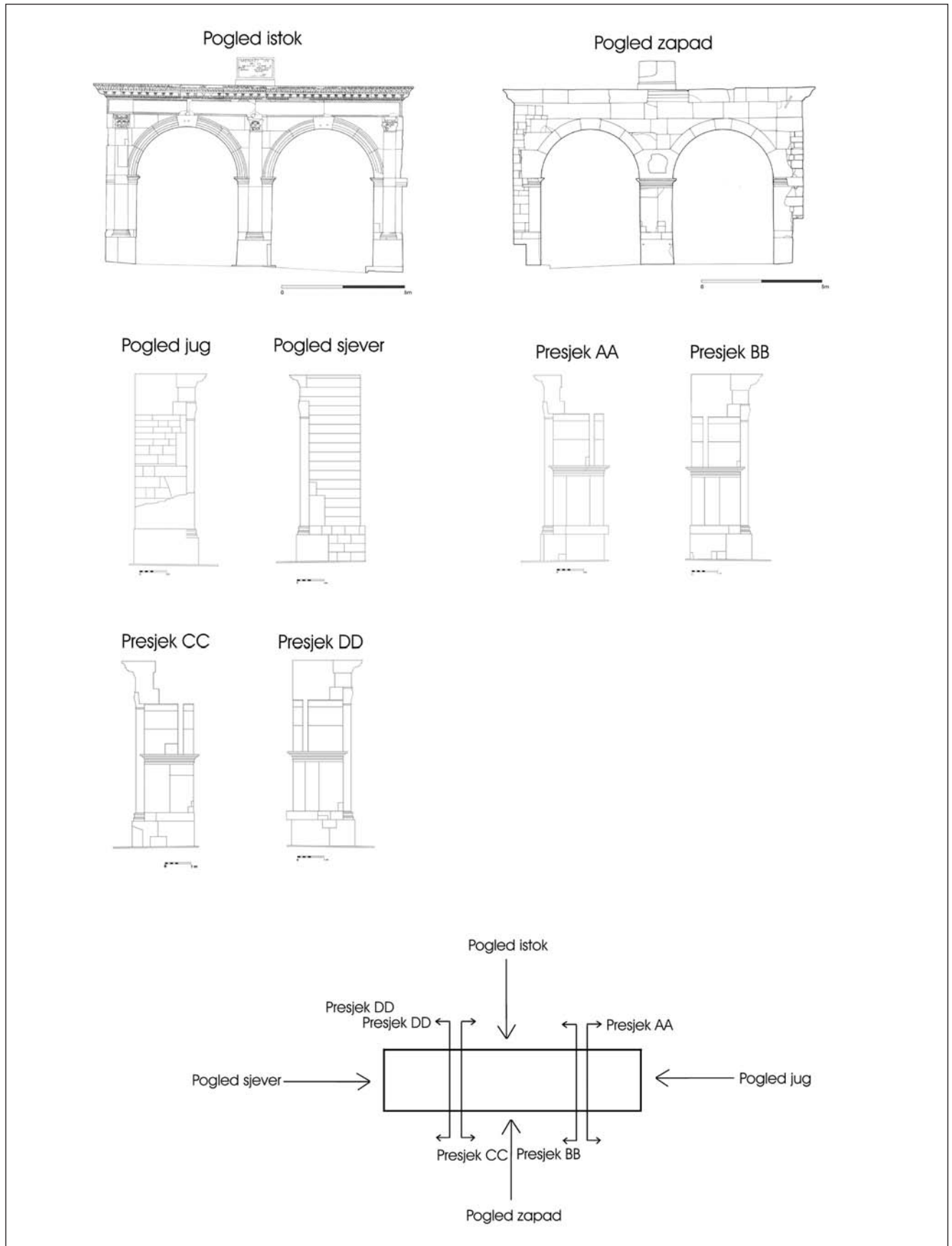
Regardless of the continuation of activities and works, it is of paramount importance that there exists a graphical, written and photographic documentation that presents a realistic image of this Roman monument in 2010.



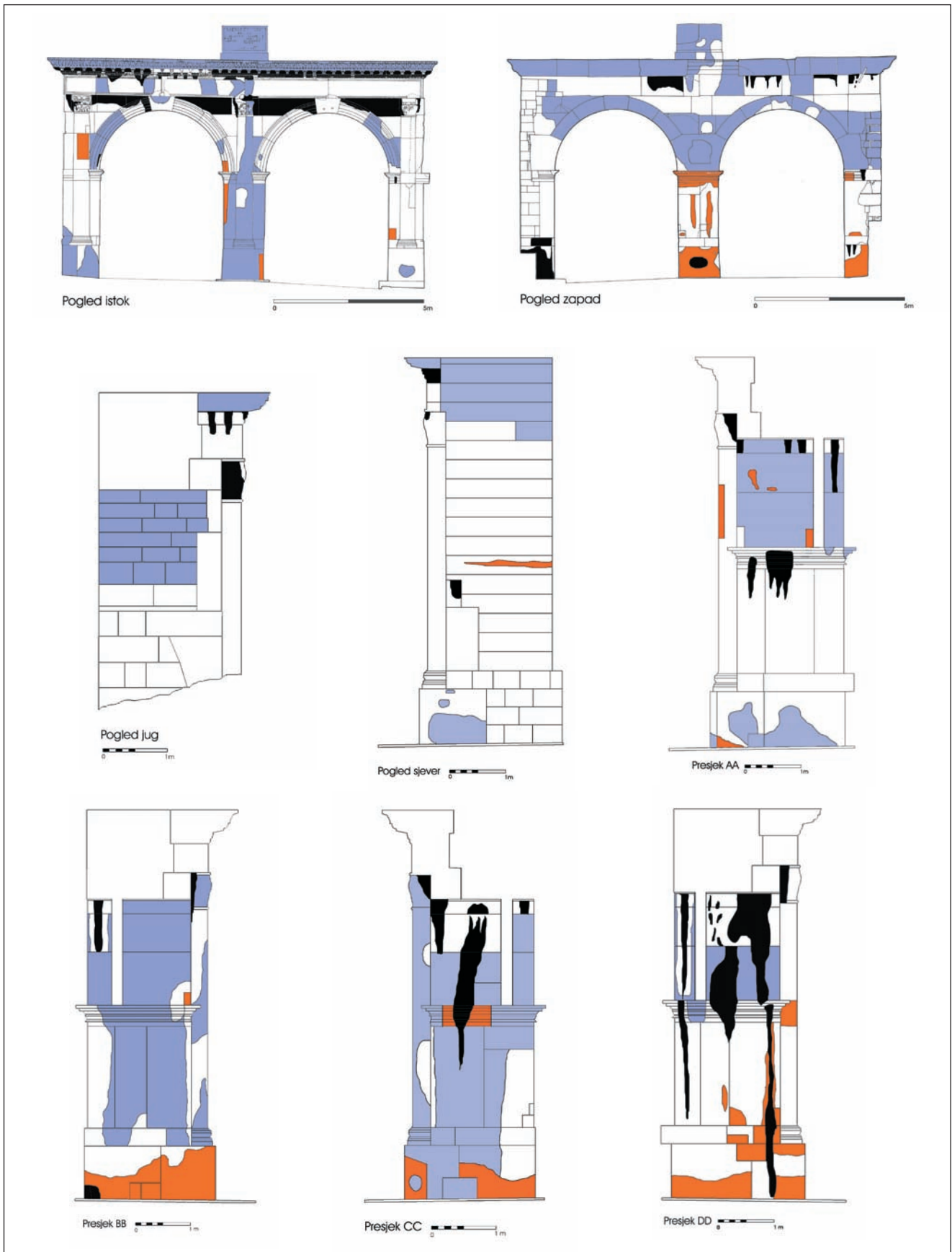
Sl. 18 Legenda degradacija
Fig. 18 Legend of degradations.

T. I. Pogledi i presjeci Dvojnih vrata uz tlocrt s označenim presjecima i pogledima

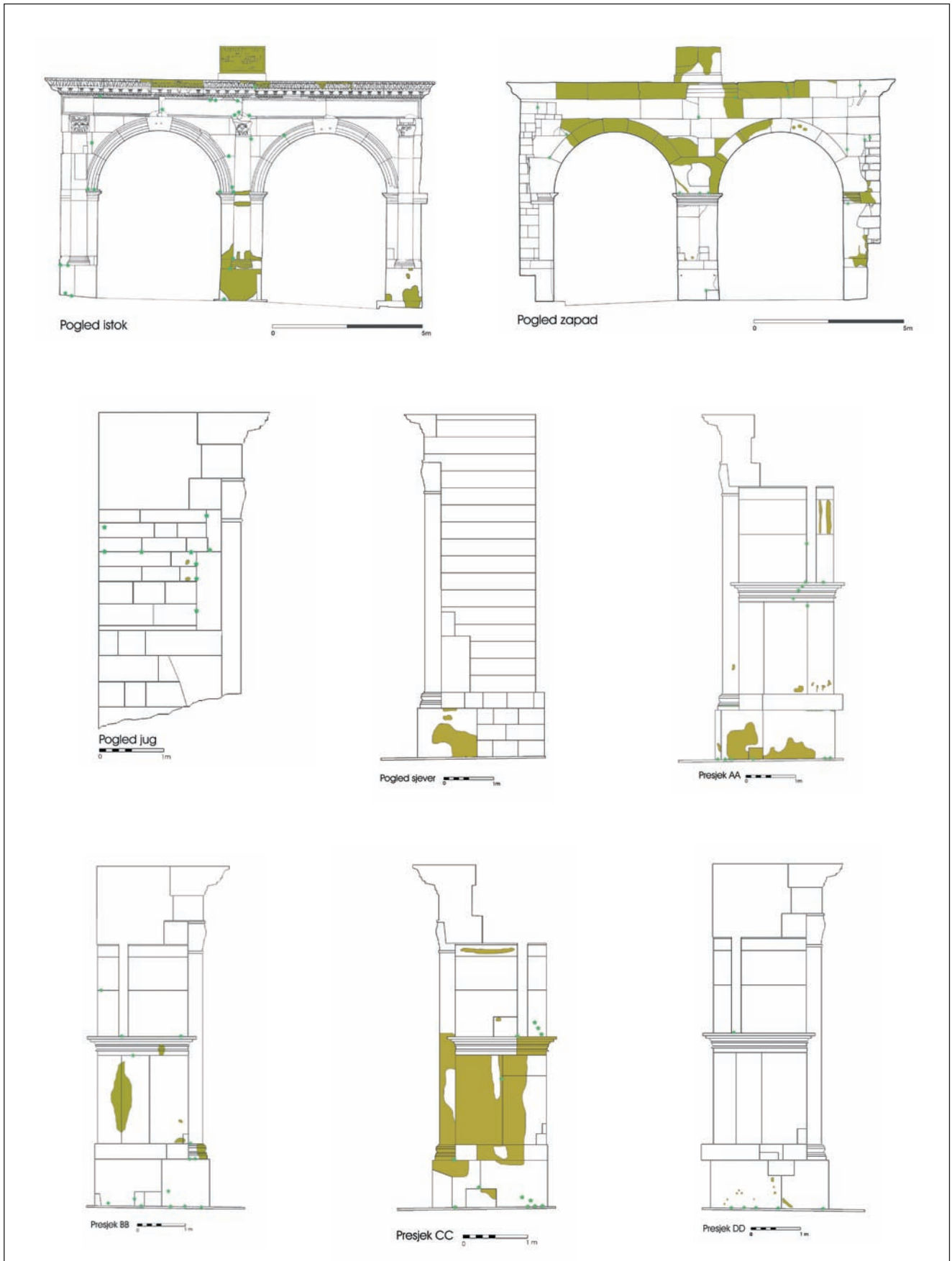
T. I. Views and cross-sections of the Double Gate along with a ground plan showing the marked cross-sections and views.



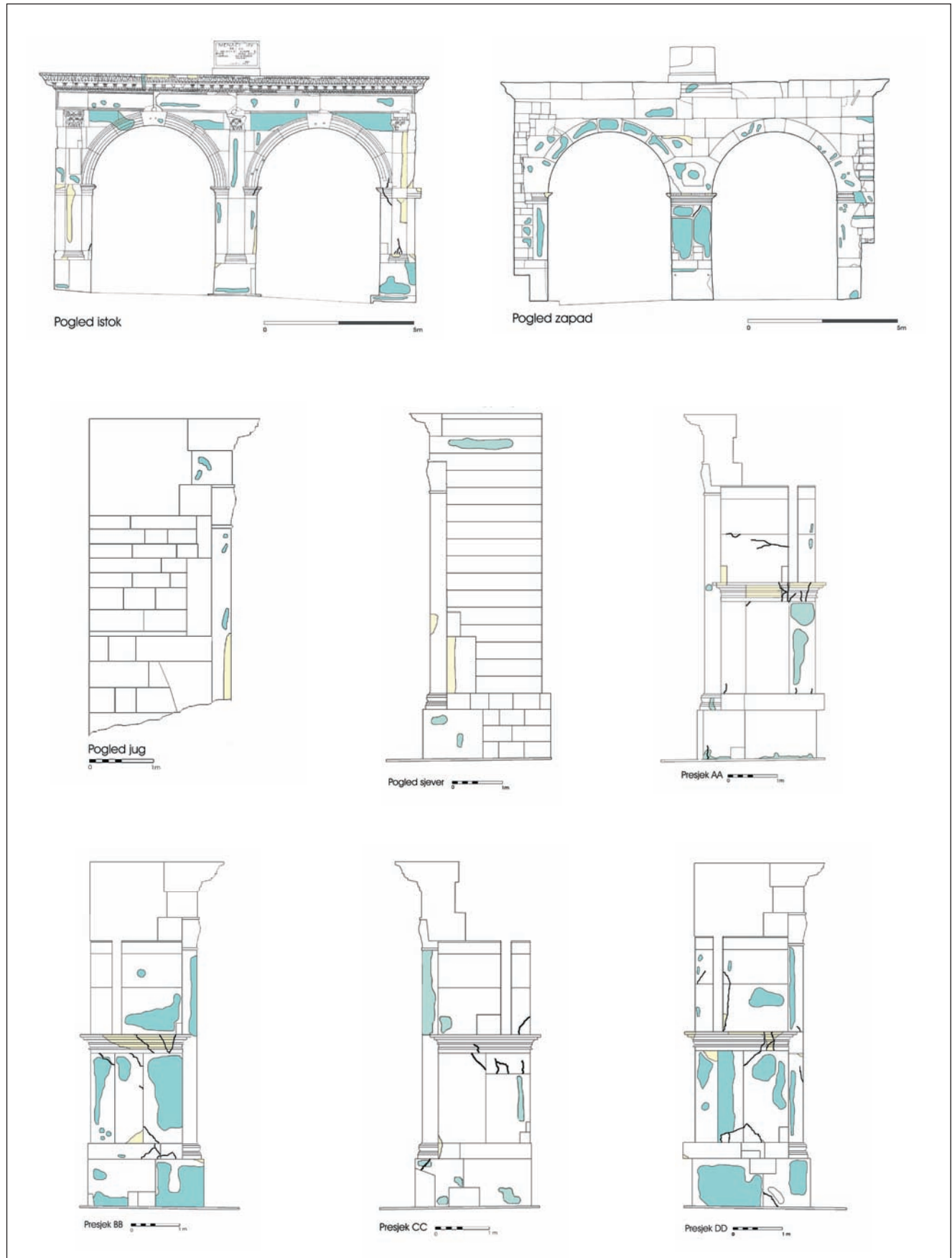
T. II. Grafički prikaz mrlja, biološkog filma i crnih inkrustacija
T. II. A graphical display of stains, biological film and black incrustations.



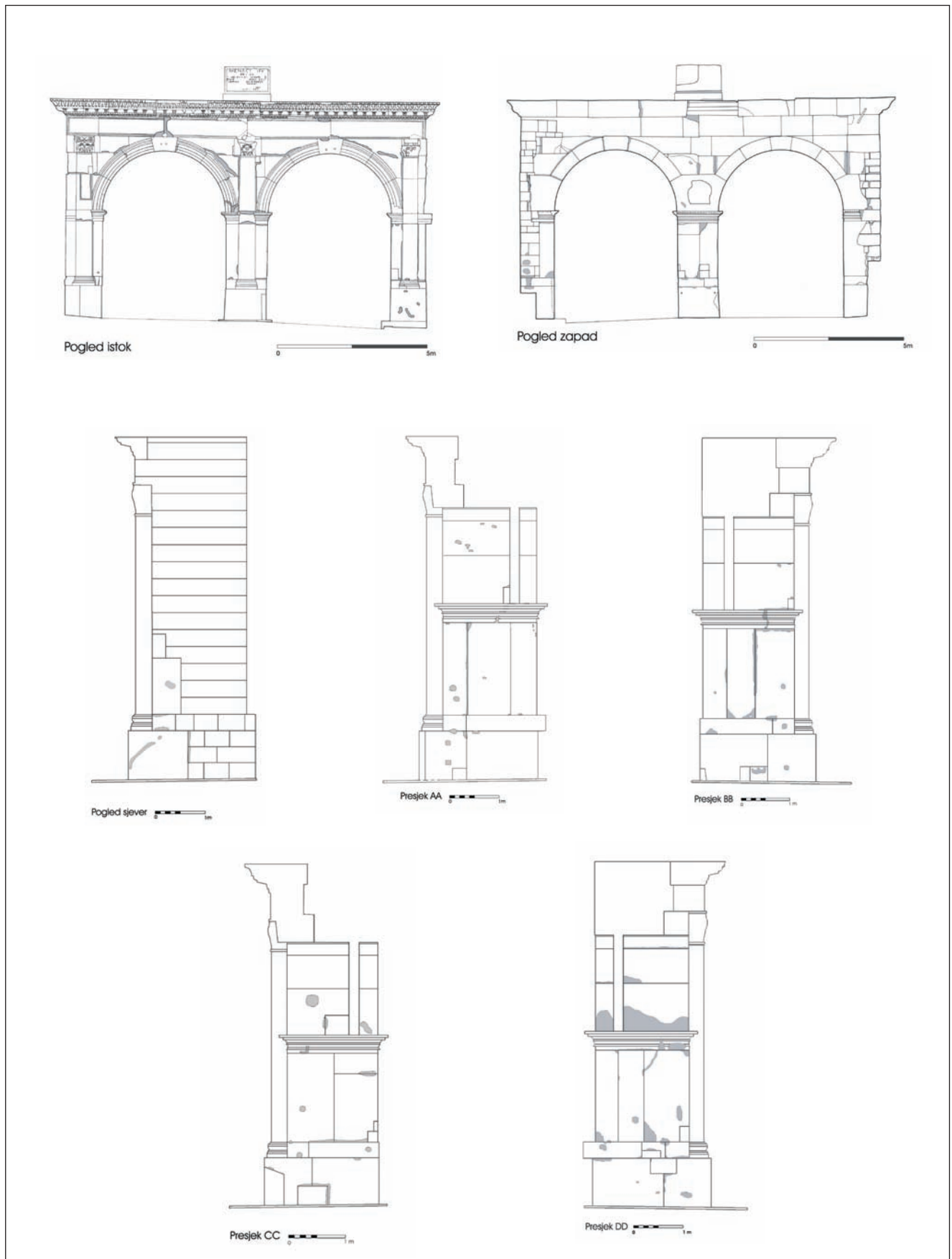
T. III. Grafički prikaz vegetacije i aktivnih bioloških patina
T. III. A graphical display of vegetation and active biological patinas.



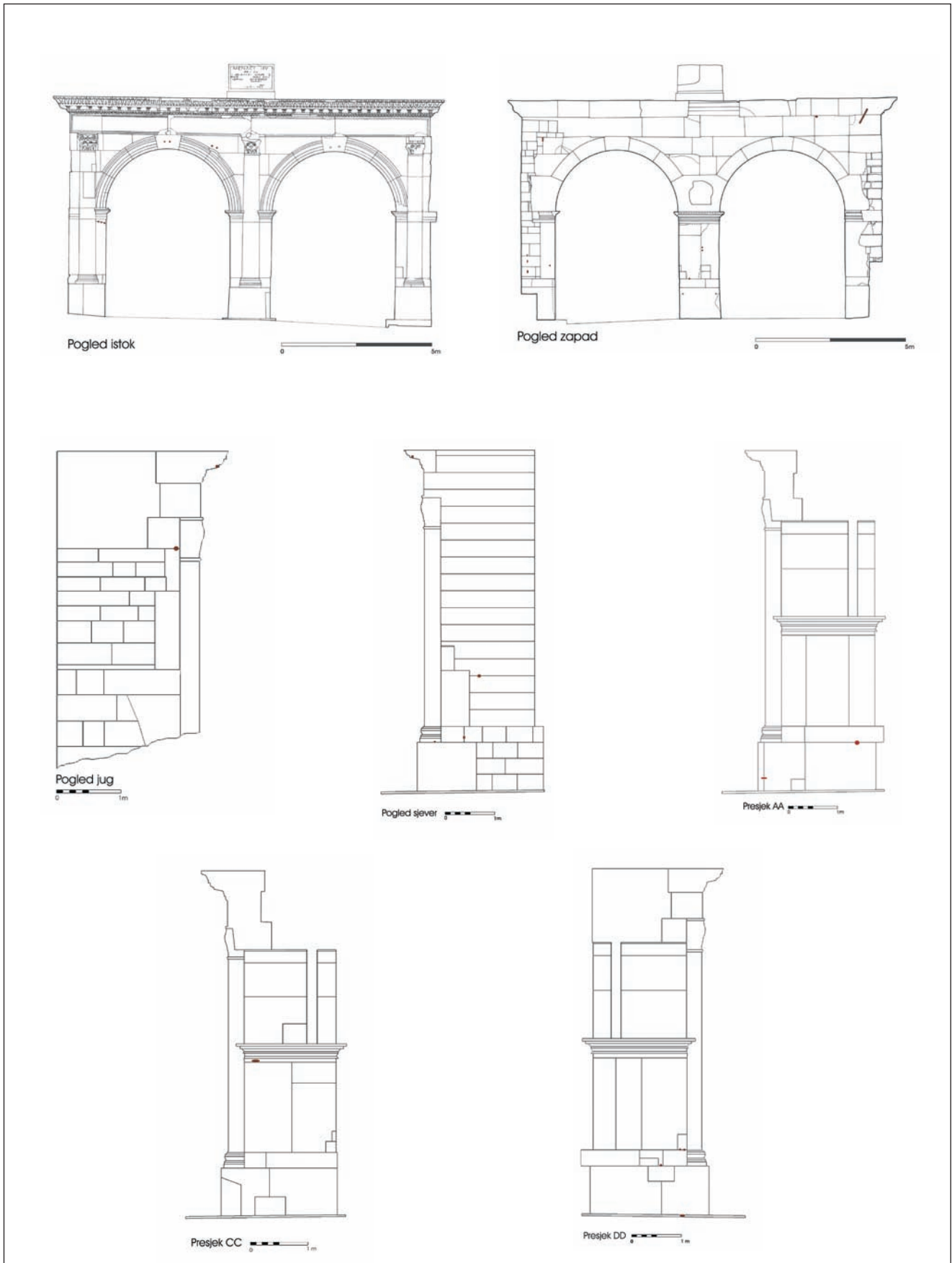
T. IV. Grafički prikaz alveolizacije, nedostajućih dijelova i pukotina
T. IV.A graphical display of alveolization, missing parts, and crevices.



T.V. Grafički prikaz cementnih ispuna
T.V.A graphical display of cement fillings.



T.VI. Grafički prikaz metalnih dijelova
T.VI.A graphical display of metal parts.



LITERATURA / LITERATURE

ALLASON, T., 1819. *Picturesque Views Of The Antiquities Of Pola*, London

ECO DI POLA, 1887. godina II, broj 60

Illustrated glossary on stone deterioration patterns, ICOMOS-ISCS, <http://lrmh-ext.fr/icomos/consult/index.htm>

KANDLER, P., 1986. *Codice diplomatico istriano*, Trieste

KANDLER, P., Atti del conservatore, Sveučilišna knjižnica i čitaonica Pula

LAZZARINI, L., LAURENZI TABASSO, M., 1986. *Il restauro della pietra*, CEDAM Padova

MALINAR, H., 2003. *Vlaga u povijesnim građevinama; sistematika, dijagnostika, sanacija*. Zagreb

MALINAR, H., 2001. Štetni utjecaji lišaja na kamene spomenike kulture. *Klesarstvo i graditeljstvo*, 1-2, god. XII, 38-42, Pučišća

MALINAR, H., 1996. Negativna iskustva uporabe portland cementa pri restauriranju kamenih spomenika kulture. *Klesarstvo i graditeljstvo*, 1-2, 37-40, Pučišća

MATIJAŠIĆ, R., BURŠIĆ-MATIJAŠIĆ, K., 1996. *Antička Pula*, Pula

MLAKAR, Š., 1978. *Antička Pula*, Pula

MÜLLER, W., VOGEL, G., 1999. *Atlas arhitekture*, Zagreb

MUSSO, S. F., 2010. *Recupero e restauro degli edifici storici. Guida pratica al rilievo e alla diagnostica*, EPC Libri

RUSCONI, L., 1926. Pietro Nobile e i monumenti romani di Pola, u *Archeolgrafo Triestino* Vol. XIII, 343-358, Trieste