VOLUME 3

TECHNICAL SPECIFICATION

1. INTRODUCTION

1.1 HISTORICAL NOTES [1]

The Besac Fortress, or as the people usually call it “the town of Besac” is situated on the hill, at the altitude of approximately 50 m, which rises from Virsko polje and Kruseva bara, right above the Virpazar community. The strategic importance of Beasc is based on the fact that from its observation posts and towers one gets a complete view of the surrounding area, especially from Virsko polje on the northwest and the Skadar Lake on the northeast. The fortress can be reached by a gravel road that can be used by vehicles, that is connected to the road Vir-Ostros, along one side of the lake for approximately 200 m.

The Besac fortress represents a fortification complex that consists of an external defensive wall, with the gate on the southern side and observation points on the northeast and southwest corners, and the inside buildings: rectangular fortification with circular towers on the northern and southern side, the building used as a military barrack in the central part, and the remnants of the supporting buildings along the southern wall. The buildings inside the walls of the fortress are distributed harmoniously and have good communication between them, in the form of cobble paved paths at various levels. Because it is abandoned and neglected for many years, the Fortress is a ruin nowadays.

Having in mind that the Besac Fortress originates from the Turkish times, the second half of the 15th century, and it is also assumed to have a younger fortification with towers inside the walls – from the period of medieval Zeta, it represented a border between the Montenegrin and the Turkish territories of the time, and thus, it has historic value. A characteristic example of the successive creation of the fortification – defense architecture, from the period of medieval Zeta (early 15th century), and the Turkish period (second half of 15th century), the Besac Fortress has an important military-engineering architectural value.

Having in mind that the contours of the external walls of the Besac Fortress and the main buildings inside of it dominate the Virsko polje and the Skadar lake, thus providing for very attractive views of Virpazar and especially of the Skadar lake, from the east side of the Godinje bay, the hill with the fortress has exceptional ambiance and aesthetic values.

Virpazar together with the National Park Skadar Lake, based on its natural and cultural resources, has a great tourism potential. An important element for the tourism valorization of the Fortress is its position, i.e. easy access and serviceability – the crossing point of the roads from the north-south direction (Podgorica-Bar) and east-west (Cetinje-Skadar). Besides, the vicinity of Virpazar and Vranjina, the two main touristic points on the Skadar Lake are

[1] 1 Text by: Regional Programme for Cultural and Natural Heritage in South East Europe 2003 – 2010. PRELIMINARY TECHNICAL ASSESSMENT OF THE ARCHITECTURAL AND ARCHAEOLOGICAL HERITAGE IN SOUTH EAST EUROPE. BESAC FORTRESS. Virpazar, Bar Montenegro.

important. Virpazar is one of the biggest communities on the Montenegrin side of the lake, with the biggest tourist offer and infrastructure, with the pier used by the ships as a starting point for the lake cruises. As the other islands on the southern side of the lake are further away from Virpazar, Vranjina hosts the Visitors' Center of the PI National Parks of Montenegro, and a pier used by cruise ships.
As the organization of organic food fairs is becoming more and more interesting, and the territory of the Crmnica region is the most productive center of producers of the autochthonous wine type "Vranac", honey, cheese, smoked fish – carp and bleak, and other products, the Virpazar community, together with the Besac Fortress could have a significant economic potential. Production of organic food, in combination with the tourist offer of this region represents an important resource.

The Besac fortress, based on its cultural and historic values is important at the national level, but based on its geographic position and natural potential of the surrounding area, it is also important at the regional level. Due to the fact that the fortress was built by the Turks, and that it is situated on the Lake shared between two countries, it also has a wider international importance.

The aim of this project is rehabilitation of the architectural heritage in support of sustainable development, in this case – protection of the cultural resource with new purpose "touristic - hospitality point for excursions and fair activities of the local population".

The preliminary intention is to reconstruct the existing buildings, with the possibility to introduce new ones, in support of the infrastructure necessities, e.g. along the southern wall, where the supporting facilities were located before, or outside the external, defensive wall, along the southern side.

Fig 1: FORT WITH TOWER

Fig 2: GENERAL VIEW OF THE FORTRESS

Fig 3: FORT - INTERNAL VIEW

Fig 4: BARRACKS

2. STATUTORY PROTECTION/CONSTRAINTS[2]

The Besac fortress is entered into the Central Register of Cultural Monuments of Montenegro (Decision no. 1217 dated 27.11.1957), as a monument of culture of category III, and it is subject to limitations regarding the interventions on the immovable cultural resource (Law on protection of cultural monuments, "Official Gazette of RoM" no. 47/91).

The direct surroundings of the Besac fortress are the Virpazar community and Skadar Lake on the east side. The Lake was proclaimed a National park in 1983. Besides, in 1995, Skadar Lake was entered into the Ramsar list as a swamp of international importance, primarily because of the birds.

The activities regarding the future purpose and use of space are defined in the planning documentation of the state (Spatial plan for the special purpose area of the National Park Skadar Lake) and local authorities (Plan for development of the small community of Virpazar). All the interventions on the cultural resource must be planned in accordance with the conservation requirements and executed under strict supervision by the authority for protection within the responsible State Institute for the protection of cultural monuments. The approval for works on the cultural resource is issued by the Ministry for Economic Development, with the previous consent of the relevant Institute for the protection of cultural monuments.

3. ARCHEOLOGICAL REPORT[3]

After the completion of the sounding archaeological researches of the "Besac" Fortress, it can be concluded that there are no moving archaeological finds, only buttons from the German military uniform were found in the probes 5 and 9.

Also, it has confirmed that "Besac" fortress lies on a natural rock, which makes its substrate structure (supstrukciju). All probes were placed at the key locations within the fortress, where the primarily findings could be expected. However, excavation layers in probes suggest that they have already been treated, or, that in the area of the fortification, earthworks have been carried out at its base.

Use of the fortress and the fact that its prime use has been converted many times since its establishment - until the mid '40 of the XX century is enough long period during which the original cultural layer was eroded. Researches show that the natural rock of the fortress "Besac", descends from west to east, which is confirmed by the fortress look, which western wall and the ground are much higher than the east one.

In any of probes traces of architecture were not found, although they were expected especially in the probes in and near the fort. Based on this it can be assumed that the castle with the circular towers is the oldest building of the fortification complex from the medieval period of

[2] Text by: Regional Programme for Cultural and Natural Heritage in South East Europe 2003 – 2010. PRELIMINARY TECHNICAL ASSESSMENT OF THE ARCHITECTURAL AND ARCHAEOLOGICAL HERITAGE IN SOUTH EAST EUROPE. BESAC FORTRESS. Virpazar, Bar Montenegro.
[3] 3 Text by: Snjezana Simovic

Zeta. It can be conclude that the Turks, as well as in other cases, have taken over the fortress and tailor it to their needs.

The optimal archaeological researches have been undertaken for a relatively short period. The archaeological researches were not carried out in eastern tower in the fortress due to obstacle of physically reaching it as well as relatively short time frame. Therefore, the presence of an archaeologist will be necessary during the revitalization of mentioned tower of the "Besac" fortress.

The most important finding regarding the dating of buildings within the complex refers to the fact that the remains of earlier buildings were not found in. Also, during the analysis of wall screens and other elements that are visible on the external and internal surfaces of walls, it was concluded that the most imposing element of the complex, the fort with round towers, seems to represent an object that was created in one phase, and, because of the material and construction methods it could be argued that this fortress was existing during the Turks time, and in that time it suffered only minor alterations.

Further, it could be concluded that the interventions which were carried out in Turkish time were related to the construction of the defensive walls, upgrading or rebuilding the guards, and possibly building on the site of today's auxiliary building, which has no cultural value.

During the analysis of insides of the objects the data which represents the starting point for the formation of stone floors in the main fortresses were found. An accurate data about the position of the original wooden staircase in the central part, and the recent circular staircase in one of the towers, also were found. Data which were previously reported about the exact position of the roof on the building barracks, as well as positions in the ceiling guards A were also confirmed. An underground connection between the fortress and the guards were not found.

During the analysis of building facades, it was concluded that all facilities were constructed as buildings with visible stone facades and access to plastering have occurred in the later stage (probably between the two world wars). That is the reason why, all facades of all buildings located within the complex should be presented as a stones one. Additional clarification, regarding the results of researches works relates to the following:

- the level of work which are necessary to consolidate the entire complex should be determined after assessing the structural condition of the complex and all its parts. Even though it is possible to apply modern materials for the remediation in the constructive sense, the final processing of all walls should be carried out using current materials;

- this means the rehabilitation of defensive walls, fortification and the auxiliary facilities, as provided within the appropriate guidelines - previously issued conditions of conservation, where the following is stated: It is necessary to thoroughly evaluate the structural condition of the entire complex and provide the necessary static consolidation, in the way that new elements of static reinforcements are not visible on the buildings facades;

- as the buildings have no roofs on and no relevant data about the authentic look of the roof of fortress with circular towers have found, it is not possible to predict the

performance of the subject roof. The walls of the upper floors of the fortress need to be preserved, with a cap conservation set. The roof of the barrack should be restored while keeping all the elements of the roof which have been determined on the site and recorded with the conservation project which has prepared by the Institute of Cultural Monument Protection. This refers to the height of the ridge and cornice, and the height and slope of roof planes;

- as the fortress with round towers is the building with the most prominent cultural values, essential to the authenticity and integrity of cultural property, during its rehabilitation is necessary to comply with all the existing data. It is necessary to keep the shape, size, number and arrangement of all holes on the buildings facades, and - as a rule, all stages from the period of the complex creation should be shown, which includes the presentation and glazing of all openings in accordance with guidance provided by local consultants, with minor repairs, and accordance with the suggestions that were previously imposed. It is not possible to predict the early stages of reconstruction of the facility and eliminated recent holes, but it is necessary to preserve the elements which were formed between the two world wars, when the larger windows sizes were made;

- in accordance with the findings of the research works, all exterior walls of facilities with circular towers and other facilities should be planned as a stone ones, which means that it is necessary to provide the removal of all parties of plaster from all sites and provide a finishing technique of grouting, called "dersovanje" (It is technique which means filling joints between the blocks and levelling the entire surface of the plaster). Recipe for the plaster needs to be adapted to the present state;

- the floors in the fort with round towers, in accordance with the findings on the spot, are necessary to be predicted as stone ones (in the central area, as well as round towers). First it is necessary to predict the return (reappearing) of the stone panel which were caught up on the spot. The dimensions and shape of the new, missing stone panels should be adapted to the present state, and it is necessary to provide more accurate and finer finish, as the difference between new and caught up elements should be indicate. In particular, it is necessary to keep all the existing floor elevations;

- the same principles-retention of existing floor coverings must be applied in the process of rehabilitation of the access road and footpaths within the fortifications. It is not possible to introduce new material for this purpose but is necessary to provide cobbling (set of stone panels of irregular size - all modelled on the existing floors);

- the rehabilitation of other facilities within the complex is necessary to predict in the way to make the consolidation and reconstruction of all elements that could be perceived on the spot, using the original, current materials, while the missing elements needs to be aligned with the existing state;

- inside of all buildings modern intervention could be performed in order to adjust the planned use of the facilities. In order to achieve the corresponding functionality, and improve building energy efficiency modern materials could be used, but in a way that their use could be confined to the interior of buildings or modern materials that are not visible on the facades.

Fig 5: ARCHEOLOGICAL SOUND

4 METHODOLOGICAL APPROACH

4.1 CONSERVATION AND RESTORATION CRITERIA

Conservation and rehabilitation of a building or of a monument needs to go through identification of general and shared tasks, capable to maintain the historical material providing new vital lymph, throughout facilities, consolidation intervention, infrastructures and innovation of the surrounding environment. Tasks are established by the community who's in charge for the custody of the property, on the base of cultural, economical and social options, but must rely on a common share idea, based on the experiences and the culture of subjects that may be even geographically quite remote. Such a common shared base is represented by the Restoration Chart that, starting in 1931, came to our days in a continuously sequence. The following methodological guidelines take into account both needs: the local ones, based on the potentially attractiveness location by a cultural and touristic point of view, and the more general ones, focusing on the need to provide technical instruments for a correct intervention on conservation.

On the base of such a premise, general task will be the following:

- respect to the structural identity: having in mind the integral safeguard of such a cultural heritage site, the structural consolidation interventions will have the aim to enhance its performances; it will be reached through the use of the historic structures as far as still working by a structural point of view, and their replacement only in case of their end of performance;

- integrated conservation: further the specific design for the site and the buildings, it has to be foreseen a broad design, able to allow the site to "survive" in the actual social, territorial, naturalistic framework;

- building materials restoration: all the historical surfaces are considered important and to be safeguarded. An operative protocol for any surface typology will be provided, in order to detect strategies and products to tackle deterioration causes;

- "readability" of any intervention, in order to let better understand the users the historic and actual development of the building / site;

- any intervention has the potentiality to be removed, if in the future the former conditions could be reached through further technologic advancements;

- compatibility: all the chosen materials and technologies must have an elevate compatibility grade, in order to not distort the building / site identity, by a physical, chemical, mechanic point a view.

Furthermore, any intervention will have the aim to detect not only optimal solutions for the building / site, but also for the environment.

4.2 CONSERVATION CONDITIONS

The design is carried out taking in strict and mandatory consideration what described by the Conservation Conditions document issued by the National Cultural Heritage Protection Institute on 20 June 2011 (no 02 - 920/1). Particularly, the design was required to adhere to all the stated conditions that are above recalled:

- the reconstruction and revitalization of "Besac" Fort is approved in line with the principle of the profession and respecting the technical norms and legislation;

- the function of all parts of the complex is specified in accordance with the design's ToR;

- prior to developing the design it is necessary to examine the encountered condition in details, to record all the findings, which includes all the elements necessary for the proper architectural analysis of the complex;

- it is necessary to make a detailed assessment of the structural condition of the entire complex and to envisage the necessary static consolidation in the manner that new elements of static reinforcement are not visible on the facades of the structures;

- it is necessary to ensure the preservation of the original spatial relationships and to envisage the maintaining of the horizontal and vertical overall dimensions of the structures within the complex, as well as the maintaining of the encountered number of floors, and all the elements of architectural plastic;

- it is necessary to retain all the elements of the roofs – ridge and cornice height and the height and the inclination of the roof planes;

- it is necessary to retain the form, size and the number and distribution of all the openings on the facades of the structures, and, as a rule, present all the stages from the time of the origin of the complex;

- for the construction of the windows and doors, it is necessary to foresee the use of high quality timber, and all the elements of the woodwork need to be made according to the traditional details of this area;

- it is particularly necessary to envisage the mounting of the entrance gate which should be made of high quality timber with massive ironwork;

- in the process of remedying the principal fort, it is necessary to respect the encountered state as much as this is possible. The remedying of the walls and the floors and of all the architectural elements needs to be planned so as to reflect the original form. It is also necessary to envisage the insulation to be applied on the upper floor so as to preserve the original vault of the ground floor and the articulated space with niches;

- the guardhouses need to be reconstructed and their floors restored according to the pattern of the encountered remains, and depending on the results in the field, it is desirable to activate the underground connection between the guardhouse and the principal fort;

- since the outer walls of the structures were made as massive walls up to 100 cm thick, it is necessary to keep them in entirety and possible measures of additional thermal insulation of the outer walls need to be limited to repairs and the interventions on possible thermal bridges;

- with the purpose of achieving appropriate functionality and the improvement of energy efficiency of the structure, it is possible to use contemporary materials, but in such a way that their application be restricted to the interior of the structure and that the materials are not visible on the facades;

- all stone walls need to be thoroughly cleaned, which comprises the removal of vegetation, of the unstable parts of the walls, stripping off the plaster and the removal of the unstable joints. New construction works and repointing should be adjusted to the encountered state with maximum use of the encountered material;

- landscape design of the complex should be covered by a special addendum to the Main Design. The remedying of the existing footpaths should be envisaged by using mostly the encountered materials, at the same time reducing new pedestrian communications to minimum;

- the unstable parts of the access road abutment wall need to be consolidated by using the existing material and the access road itself needs to have paved finish;

- all the earthworks within the complex, but also in its immediate vicinity, need to be extremely carefully undertaken, since it is possible to uncover the remains of the older structure – in which case it is necessary to envisage their conservation and presentation;

- the mounting of electrical installations needs to be planned in such a way that the encountered values and the integrity of the cultural property are not harmed.

4.3 PLANT INTEGRATION

The life of a architectonic complex, of any kind, is strictly linked to its physic conservation. This existence has been possible through times because of its design, based on the parameters of his time (living comfort, technologies, use, social class, etc.); it remains possible if, while going through transformation and changes even radical, such parameters are kept. Restoring a building is not only an intervention of consolidation and protection, but also giving back the monument to a user, after a careful “reading” of its functional and typological features. It is, so, necessary to provide with the same efficiency the protection of an historical building and its “reutilization”, intended as the use of a fabric for a specific task, even if different from the original one; in this idea falls the problem of the choice and the design of technological plants. The approach of the inserting of plants in an historical building is quite difficult, because it doesn’t exist a standard which will provide systematic solutions and matching of two needs that often seem contradictory:

- Respect of the architectonic and physical constraints of the building;
- Envisage advanced plant solutions and appropriate to the new intended use of the fabric.

Often, if the intervention is not well studied, the same intervention results not well integrated, unbalanced though a merely conservative point of view or through an unacceptable impact of plants on the historicartistic peculiarity. The restoration design, architectonic and plant, must not, therefore, regardless a careful survey of the existing situations and of the analysis of possible intervention, compatible both from the point of view of the protection of the history of the fabric, and from the point of view of efficiency of function delegated to plants. Main constraints to take into account are of two types:

Architectonic:

- Protection of the most remarkable characters of the building (façade, frescos, decorations
- and stucco, vaulted ceilings, etc.);
- Protection of masonry from inappropriate intervention (break - in, holes, tracks);
- Minimization of the impact of plants in the most important halls;
- Reuse of traditional equipment (chandeliers, radiators, sinks, etc.);

Plants:

- Integral conformity to the laws, general and specific in the intended function (hospital, schools. Library, etc);
- Existence and suitability of volumes and rooms to assign to technological areas (thermal power plants, elevator space, dumping, etc.);
- Search for horizontal space for the main distribution (loose stone foundation, etc.) and at the floors (false ceilings, garrets, etc.);
- Functional requirements: appropriate lightning, environmental comfort (cooling/heating), security system, alarm and monitoring, etc.

Usually, except eventually for the reuse of terminal equipment, restoring an existing building involves a radical remake of the plants or a new insert, in case plants does not exist; therefore the necessity to study plants so that one can:

- Reduce impact on fabric;
- Use rooms and volumes existing;
- Design properly the plants, fallowing the technical regulations.

The main problems to undertake for the proper design of specific plants are the following:

1. Heating and air conditioning:
    - Search for the space for thermal power plant for the refrigeration unit and substations;
    - Tracks for the air exchange system (sent and recovery)
    - Tracks for the distributions pipelines (generally under the floor);
    - Placement of the thermal unities.

2. Water and sanitation facilities and discharges:
    - Proper placement of water in relation with discharges;
    - Supply pipes and secondary ventilations ducts;
    - Rooms ventilation systems.

3. Lightning:
    - Research for the more appropriate lightning solutions;
    - Minimization of tracks and backgrounds for lights, lights control, etc:
    - Continuous lightning systems (profiles, frames, etc.) rather than point.

4. Electric plants, communication and security:
    - Vertical distribution: in atrium or pipelines dedicated;
    - Horizontal distribution: in false ceiling, inside conduits in the wall or in skirting
    - Problems of coexistence of plants with different voltage and of connection to final utilities.

5. Fire prevention system:
    - Escape routes dimensioned to the use of the building and to the crowds;
    - Survey of compartmentalization, of filters (aired), of stairs (smoke control, protected, etc.)
    - Sizing of the water – fire prevention system and of other safety equipment (lights and safety signals, fire detection and extinguishing system, etc.).

5. GREEN SUSTAINABILITY SOLUTIONS

The "Besac" Fotification is located in a very remarkable environmental context, with a important flora and fauna heritage to be protected. Reuse and consequently the touristic flows that it could attract must not alter such balance. Therefore, also design must be oriented to the environment protection, reducing the waste of resources and the use of pollution material.

Some of the basic design principles are:

- Optimize the relation between the building and the context in which it is located;
- Privilege quality of life and wellbeing of human being;
- Protect the ecosystem;
- Use natural resources (water, vegetation, climate);
- Reduce harmful emission (smoke, gas, wastewater, waste);
- Conceive flexible solutions and eventual removals, substitutions or integration of plants, and possible enlargement or change of intended use;
- Provide a large scale use of renewable energy;
- Use of eco‐sustainable material and techniques, preferably belonging to the local material culture;
- Evaluate which material to be use, giving preference to the natural ones and locally produced, beside being less polluting in the phases of production and disposal:
- Design electric plant that reduce as much as possible the presence of EMF;
- Chose building typologies that allow a proper transpiration and ventilation of the building;
- Use of plants that will reduce electrical consumption and apply all necessary measures to reduce heat loss.

Therefore, starting with the preliminary phase, it will be necessary to identify strategies and implementation measures, capable to satisfy such requirements. You may identify two main lines of action:

- Material options;
- Low impact plant solution.

The options on material must imply a less consumption of non‐renewable and polluting resources and must satisfy requirement of the attached scheme. Regarding plants, instead, it is necessary to provide the possibility to install high efficiency machinery, so to reduce consumption, solutions aimed to deliver facilities only in the presence of users, exploitation of the natural thermal inertia of historical masonry therefore to limit the use of air conditioning plants, use of lighting with low consumption led.

Such basic indications will allow a rational use of resources and will assure the compliance with the most modern and innovative regulations of the sector.

6. USE OF FORTRESS "BESAC"

The intended use and the content/facilities are below resumed:

- within the larger structure of the barracks: polyvalent hall having as a primary function the art gallery with the library, research station and video‐beam;
- within the smaller structure of the barracks, the museum hall;
- fort with towers: wine boutique (Montenegrin wines) – tavern, with belvedere on the upper store;
- the observatory posts: make them usable and equipped them with adequate equipment for viewing the panorama;
- ancillary premises: small structure should be planned for a souvenir shop, while the large structure (sentry post) should be equipped in adequate manner in order to look like sentry post from the time when it was in use;

- the area within the walls should be arranged as landscaped area with amphitheatre, with the possibility of showing video projections outdoors as well as for holding of other outdoors events;
- the area outside the fortification should be planned for accommodation capacities (examine the possibility of using the nearby structures and placing camping tents) for an artists' colony (artists' club), researchers' colony (considering that the aetiological site Mijela is located nearby); These proposed new constructions should not affect the visual effect of the Fortification and existing vegetation;
- adequate lighting for the Fortification, i.e. for the interiors, exterior, walls, and access road;
- vehicular access road with arranged parking spaces that would not affect the visual effect of the Fortification and existing;
- adequate access road for disabled persons.

7. THE ACTUAL CONDITION OF THE "BESAC" FORTRESS

The fortress, actually not in use, is constituted by two main buildings, flanked by secondary service structures. The compound is enclosed by defensive walls, with a unique opening represented by the entrance. The most used materials are: local stone for the walls, mortar plaster based on the fracturing of the same stones; furthermore, it is supposed the wood was used for the floors. The fortress is not served by any facility, such as water and electricity. Due to the neglected state, the decay is very notable and involves both the materials and the structures.

7.1 Site Decay

The decay analysis starts observing the present site usability conditions. The path leading to the fortress is usable, but trees and bushes often overrun somewhere. Also the portions outside the buildings are infested by bushes and grass, freely grown due to the abandonment.

7.2 Structural Decay

The analysis of the present structures and first evaluation of their static conditions, lead to some preliminary considerations that are useful to address the recovery intervention. In general, those structures are not affected by instability. It is due to the relative small size of the buildings and to the presence of compact rock foundations, which have not allowed structural failures. Only few structural damages are sign of the still good health of the walls.

External walls: They are built with stone blocks roughly cut, with the traditional technology of "sack wall"; they show localized collapses along the whole perimeter, sometimes only on the crown. The collapses are due not only to lack of maintenance, but also by the presence of bushes. All the crowns are lost, thus it is very hard verify both the former dimensions, and how they were built.

Fig. 6: DEFENSIVE WALLS - LOCAL COLLAPSE

Guard posts: They show extensive collapses, involving both the roof, totally lost, and portion of perimeter walls, built in the same way of the external one, being their extension. Also in this case it is not possible establish the former height dimensions; in the north‐western guard post we assume a wooden ridge roof; furthermore, the eastern one shows the former existence of two levels, divide by a lost floor.

Fig. 7: SOUTH GUARD POST

Service buildings: They show the same situation of the guard posts (same building materials, masonry technology, and collapse of roofs and portion of the walls.) Only the smallest building still conserves in good conditions the former vault.

Fig. 8: NORTH GUARD POST

Fig. 9: SERVICE BUILDING FORESEEN AS A SOUVENIR SHOP

Fig. 10: GUARD BOX

***Barracks*:** The building shows two regular rectangular portions, with different dimensions. The former wooden ridge roofs have been lost. The collapses are localized at the openings and on the crown where the wooden roof was built. No specific lesions have been noted: it means the foundations still conserve a good performance. The walls have been built with stone cut in a more refined way, maybe due to the different use of the building.

Fig. 11: BARRACKS

Fig. 12: BARRACKS

Fort and towers: Undoubtedly, it is the more representative building and the more challenging one by a structural point of view. It is composed by an almost rectangular main hall flanked by two cylindrical towers. The towers shows extensive collapses in the upper portions, without roof and part of the walls, consequently it is not possible understand the shape of the former roofs, even though we could assume, through ancient photos, they were wooden sloping roofs. The main hall, accessible through stone steps, shows localized collapses of the external facade and some closures that do not allow the access to the towers. The roof is a vault built with cut stones. It is assumed that the existing level formerly had an upper level, accessible by the eastern tower, but actually there is no evidence of it, except and old photo apparently showing it.

Fig. 13: FORT WITH TOWER

7.3 Material Decay

It is mainly due to the lack of maintenance and not to their quality, that is good, or their incorrect in place disposition.

Stone decay: The stone is white - colour compact limestone, with some red signs in correspondance of iron devices. Its decay is typical of the limestone exposed to the action of rain, wind, snow. The main alterations are the following:

- colour changes;
- crusts having limited extension, dark colour;
- cracks in correspondence of blocks under - dimensioned or over - stressed;
- surface layer composed by extraneous material;
- delamination;
- biologic “patina”, green colour in almost the cases.

Fig. 14: EXAMPLE OF STONE DECAY

7.4 Plaster decay

It is applied on the external surfaces of the fort and of the towers, and on both the barracks. It is double layered. Formerly it had light brown colour, but actually has grey colour, with large lacks. The main alterations are the following:

- colour changes;
- craquelure;
- surface crusts;
- surface layer composed by extraneous material;
- lacks of parts of the plaster and stone blocks;
- biologic “patina”, green colour in almost the cases;
- dustering.

Fig. 15: EXAMPLE OF PLASTER DECAY

8. SCOPE OF WORKS

8.1 AIMS & OBJECTIVES

The objective of the Work is to restore the "Besac" Fortress, as described in the introduction and project policy. The works primarily include the restoration of deteriorated masonry fabric and removal of any biological growth and cleaning. No replacement of missing pieces shall be carried out unless otherwise specified.

The scope of the construction/restoration works, included in the present Tender, is generally limited to construction Phase I, but some minor elements of Phase II must be constructed as well, all in accordance to the items of the works specified in the bill of quantities (Volume 4).

The principle underlining the approach of restoration is to restore the remains as a ruin. The policy of minimum intervention must be adopted wherever possible, subject to instructions by the Engineer in charge. Missing pieces, for example, should not be replaced unless the damage is a hazard to the remains, or unless otherwise specified by the Engineer in charge.

Photographic records are required of all historic features that may be uncovered and exposed during the restoration works. Surveying and recording of the investigatory works herein described will serve to supplement the existing information.

All works shall be carried out with care and sensitivity. When tendering, the contractor shall be aware that he shall take all necessary precautions for the safeguarding of the ruins, and shall assume responsibility for the protection of the ruins on site during ongoing works.

Prior to commencement of works and when required so by the Engineer, the successful contractor shall be required to produce a detailed method statement outlining the proposed procedure of intervention and specifying materials to be employed for the restoration intervention.

The method statement shall be submitted to the Engineer for approval, and prior to the commencement of works. In addition to this, the contractor is to conform with the Construction Management Plan as prepared by the project manager of the Project, in order to be able to establish how to access the site and handle building materials and waste on site to ensure minimum impact.

8.2 FACTUAL REPORTING

The Contractor shall submit weekly factual reports of site operations describing the interventions, works uncovered, findings and instructions received. The report shall be presented in PDF format and shall contain, but not be limited to the following information:

- Introduction
- Site location & Description
- Description of procurement
- Findings
- Photographs of Works
- Instructions received.

All the above shall be accompanied by a full measurement survey together with a photographic report summarizing the findings.

9. RESTORATION AND STRUCTURAL INTERVENTIONS

9.1 EXTENT OF WORKS

Prior to the commencement of works, the building shall be inspected together with the Engineer to confirm the extent of work and restoration methodology employed, making sure the method statements requested are submitted by the tenderer and comply.

9.2 REMOVAL OF CEMENT RENDERS/LIME WASH RENDERS/WATER BASED PAINTS

Where identified by the Engineer, concrete/ cement renders/ lime wash renders/ water based paints shall be carefully remove by hand tools using manual methods so as to contain damages to the underlying masonry work. Electrical tools as well as tipped metallic instruments with sharp edges or corners, power tools (such as rotating disk cleaners) and sand blasting (dry or wet) shall not be permitted, unless otherwise instructed by the Engineer.

9.3 REMOVAL OF ADDITIONS/ACCRETIONS

The Contractor shall ensure the careful removal of all accretions from the facades of the building. The methodology employed for this removal shall be approved by the Engineer prior to commencement of works. Care shall be taken to remove all metallic inserts, (especially iron and steel fixings) from the stonework.

Corroding metal fixings shall be carefully cut so as to cause the least possible disturbance to the surrounding masonry; the associated rust debris shall also be carefully removed. Resulting holes shall be filled-in using a suitable lime-based mortar when the break is small or by piecing-in stone, if the gap is large, as per specification.

9.4 DISMANTLING OF MASONRY STRUCTURES

All dismantling of masonry sections for subsequent reconstruction shall be carried out carefully by experienced personnel, care shall be taken to ensure that during the dismantling procedure each stone block is numbered and referenced to a drawing, specified image, photograph etc as directed by the Engineer and Civil Engineer in charge.

The masonry blocks/sections shall be removed in their entirety. Each unit shall be identified clearly and indelibly on concealed faces. The methodology to be employed shall be discussed with and approved by the Engineer and Civil Engineer in charge prior to the commencement of works.

All masonry units shall be cleaned from old mortar, soil etc and stored in a manner such as not to cause any damage.

9.5 RECONSTRUCTION OF PREVIOUSLY DISMANTLED STRUCTURES

Reconstruction shall be carried out by experienced personnel who shall ensure that the original face and joint lines, joint widths etc are respected to ensure that the final work matches the original in all respects. Care shall be taken to ensure adequate bonding at junctions with the retained original structure.

The bedding surfaces of the masonry blocks shall be dampened with de-ionised water having conductivity inferior to 60 μS to control suction. The masonry blocks shall be laid on an evenly buttered bed of mortar prepared from a mixture of suitably slaked air line, and stone dust. Care shall be taken to ensure that the exposed surfaces of the masonry blocks are kept clean.

The Engineer and Civil Engineer in charge shall indicate and approve which of the original masonry units shall be replaced.

9.6 REMOVAL OF VEGETATION

Every effort shall be made to remove all parts of biological growth including roots and stubs. Plants/ weeds shall be removed by carefully cutting the plant at the base of the stem and then by the introduction of a suitable biocide to kill off the remaining part of the plant.

The product to be used should result in the desiccation of the plant after it has been absorbed; the dead parts will then be easily removed by hand, without risking re-growth.

The following factors shall determine which chemicals will be used:

- Chemicals which do not cause damage, chemically or otherwise, to the stone;
- Chemicals which do not create any risk to man or other life forms , apart from the ones treated, taking into account their toxicity;
- Their activity period and residual effects;
- Do not contain harmful salts or other substance which can instigate or accelerate the deterioration of the stone.

9.7 RAKE OUT JOINTS

Power tools may not be used for the removal of renders, mortars and opening of joints unless explicitly requested in writing by the Engineer. Hand held tools to be used.

9.8 POINTING

The re-pointing of masonry will be necessary in cases where the existing mortar has weathered out, consists of cement or where it has become friable or loose. Mortar tests were carried out by an independent laboratory and these were analyzed by a Stone Conservator. Refer to this document for the conclusions on the types of mortar as necessary.

Due the variation of the existing mortar colour the new pointing should be similar in colour to the adjacent original pointing mortar. The difference in colour should be brought about by adding a colour additive.

Various on-site trial/samples should be carried out in areas were these different mortar types are used for approval by the Engineer.

The following will apply in the pointing procedure:

- Where the wall is tight-jointed, no raking out of joints shall take place unless otherwise indicated by the Engineer.
- Small mason hand tools, including hacksaw blades and narrow screwdrivers shall be used.
- Portland cement mixes will not be permitted, unless otherwise instructed by the Engineer.
- All mixes shall be lime-based, and will also be as close as possible in colour, texture to the original mortars.
- Pozzolanic or similar additives shall be preferred alternatives to give strength and durability to a lime based mix, unless instructed otherwise.

The properties of the mix shall be improved if hydraulic lime is used as an alternative to both hydrated lime and pozzolana. In the former case only aggregate shall be added; no cement or other pozzolanic additives shall be necessary.

9.9 PREPARATION OF MASONRY STRUCTURE FOR POINTING

The existing mortar shall be carefully removed without damaging the adjacent masonry or widening the joints using small hand-held chisels to a minimum depth of 25mm and never to a depth less than their width. Impact tools shall not be used. Power tools such as rotary discs (chasers) will not be allowed.

If mortar has failed to such an extent that the joints are largely empty, then the joints will be deep tamped and, if necessary, hand grouted to fill the voids up to the distance required for pointing.

Prior to pointing/re-pointing, all open joints shall be cleaned from dust and loose materials, and the surrounding stones adequately wetted by water as specified in this document

The work shall commence at the top of the wall moving downwards.

If joints exhibit biological soiling, a biocide should be applied prior to flushing out.

9.10 POINTING METHODOLOGY

Where pointing is considered necessary, subject to the Engineer, the Contractor shall clean and dampen the joints with clean water as specified in this document

The mortar face shall be kept as far back as required to achieve the original joint width.

If the stones have retained sharp edges, joints shall be filled flush unless the original joint face was profiled in some other way. In the case of weathered edges, or where the stone has spalled off, the face of the new mortar shall be kept back such that the apparent joint width does not increase.

The Contractor shall ensure that all pointing is built up in layers not exceeding 10mm in thickness.

The mortar shall be built up and firmly applied in layers until the specified thickness is reached; the Contractor shall ensure good adhesion with no voids. A mechanical key shall be formed to the undercoat/s by combing or scratching so as to produce evenly spaced lines.

Each layer shall be allowed to achieve an initial set prior to the application of subsequent coats (minimum 24hrs), and prevented from drying out too rapidly by covering immediately with plastic sheeting and/or dampening intermittently with clean water. All pointing shall be left shy from the surface, however, all pointing shall be such as to inhibit any water during the cleaning process from lodging into the structure.

When using lime mortars, the fresh mortar shall be kept as humid as long as possible to slow down setting rate and hence avoid cracking. Ready-mixed lime mortar shall only be used if approved by the Engineer.
After application, but prior to setting, the area around the joint will be sponged down with water to remove the residue from the adjacent stone

After the initial set has taken place, the Contractor shall stipple the joints with a stiff brush to remove laitance/excess fines and achieve a coarse texture.

All pointing shall be carried out in moist, warm conditions

Fresh pointing shall be allowed to dry slowly and be adequately protected from excessive heat and direct sunshine by a tarpaulin, and should occasionally be wetted to avoid cracking.

A minimum of 24 hours shall be permitted between the applications of each layer of pointing.

When laying new stonework, all vertical and horizontal joints shall be adequately buttered with mortar.

9.11 PLASTIC REPAIR

Plastic repair as specified in this document shall be used in areas indicated by the Engineer.

Any deteriorated, flaking, powdering etc masonry shall be carefully removed to expose a sound background. In the process care shall be taken not to weaken the structure or damage the adjacent masonry.

The top and vertical edges of the repair area shall be undercut to provide sufficient bonding and reduce the formation of visible shrinkage joints.

Suitable non-ferrous reinforcement approved by the Engineer shall be used for all plastic repair interventions which have a projection of more than 40mm from the stone surface or an area which exceeds 50mm by 50mm.

Pre-fabricated glass reinforced polyester, or epoxy rods having a diameter of not less than 6mm shall be used. Holes shall be drilled with the background to form a grid of dowels fixed not more than 40mm apart. Dowels shall have a minimum anchorage in stone of 60mm, and the Engineer may request that this bedding depth be increased. All dowels shall be adequately bonded to the masonry fabric with an approved epoxy resin.

Adequately gauged stainless steel wire shall be used to form a mesh between the dowels. This mesh shall be secured to the resin dowels.

When preparing the reinforcement, allowances shall be made to ensure a minimum cover of 20mm.

The plastic repair mortar shall be based on a lime binder and it can be premixed.

Aggregates used shall vary from coralline sand, to pozzolanic additives, as agreed with the Engineer.

The mixes shall approximate a 1:3 binder to aggregate ratio, unless otherwise agreed the Engineer. In the mortar preparation, the Contractor shall ensure that the grains of sand and stone dust are adequately coated with the binder paste.

Slaked lime shall be used as a binder, with the putty mixed wet with the aggregate and stored in an airtight container as far in advance as possible.
Hydraulic lime may be used to substitute completely the slaked lime, as per the Engineer instructions.

The mortar shall be built up in layers where necessary, each layer not exceeding 12mm.

The finishing coat shall match the existing surfaces and approved sample/s.

The Contractor shall ensure that repair mortar is not stronger than the adjacent fabric.

When plastic repair is used to fill alveoli then the extent of filling shall be determined on site by the Engineer and shall reflect the physiognomy of the deteriorated masonry fabric. All plastic repairs shall be formed such as to match the adjoining stonework in colour, texture and final profile.

9.12 ADVERSE WEATHER

Wet methods of surface intervention (including re-pointing) will be suspended, or suitable protection provided. The Contractor shall protect works against damage by rain and necessary precautions shall be taken by the Contractor to prevent the masonry bedding from drying out too rapidly in hot conditions and in drying winds.

9.13 REPLACEMENT OF DETERIORATED MASONRY

Every effort shall be made to retain as much as possible of the original masonry structure. To this effect no stone shall be replaced without the prior approval of the Engineer.

Stone replacement will be limited to individual badly deteriorated stone blocks and the total number of stone replaced shall be kept to the minimum possible.

All new stone work used shall be similar in material, colour, size and configuration to the original and shall match with the existing course height.

Methodology employed for the cutting away of the deteriorated masonry sections may vary depending on the particularities of every individual case. Nonetheless, care shall be taken to ensure that only hand held tools and small power tools which do not cause damage to the structure and/or immediate stone blocks will be used. The methodology employed shall be discussed with and approved by the Engineer prior to the commencement of works.

The cutting of perimeter joints may be carried out with a masonry saw. If stone is to be retained, the cut shall be made by a purpose-made fine saw blade or with a plugging chisel in the case of a wide joint. Where stone is to be replaced, the stone shall be chiselled away starting from the centre and moving towards the edges.

The extent of additional replacement, to that indicated in attached drawings, shall be established with the Engineer.

9.14 STRUCTURAL STABILITY

The contractor shall ensure that the stability of the masonry structure is maintained throughout the work.

Any defects, including signs of movement that develop or become apparent during the course of the works shall be immediately reported to the Engineer.

9.15 GROUTING JOINTS

Grout mix shall be based on lime and local sand.

Joints around replacement masonry units shall be thoroughly grouted wherever joints cannot be fully filled with bedding mortar.

The grout shall be kept back from the exposed face to allow for the depth of pointing specified; this shall be achieved using an approved temporary sealing material. The Contractor will ensure that the grout does not stain the exposed face.

The Contractor shall not point replacement masonry until all the work has settled-in. The pointing of the outer 25mm (as a minimum) shall be left until all bedding work has settled.

9.16 JOINTING OF MASONRY WORKS

Replacement stone shall be cut and shaped with such a manner as to ensure the minimum loss of the original material, yet provide a firm seating for the replacement.

All existing joint widths shall be respected and bridging of joints will not be permitted.

The pockets to receive inserts shall be accurately cut with small, sharp chisels and small saw blades to a neat, square profile. The sides of pockets shall be undercut, where necessary, to provide space for specified bonding material.

Where so directed by the Engineer, the contractor shall dove-tail the new insert with the original to ensure adequate bonding.

The pocket shall be cleaned out thoroughly and the inserts installed accurately and securely. The Contractor shall ensure that no bonding material encroaches upon the exposed faces.

Piecing-in may also be carried out in larger areas, in which a piece of stone is added to fill in a missing area or replace a part of a deteriorated stone by the insertion of an appropriately cut stone piece, attached using structural adhesives (e.g. epoxy or polyester adhesives), as approved by the Engineer.

9.17 BONDED DOWELS

The Contractor shall submit samples/ method statements for the use of stainless steel, glass reinforced or epoxy resin dowels used in conjunction with polyester or epoxy resin adhesives shall be used, and as approved by the Engineer.

Suitably sized holes shall be drilled in the background and rear of the replacement/insert to receive dowels and adhesive. The Contractor shall ensure that the holes are aligned to allow accurate positioning of the replacement/insert and that enough depth is allowed for sound anchorage.

The holes shall be cleaned, all dust removed and adequately flushed with water; adequate drying time shall be allowed. Smaller holes may also be cleaned by blowing out with a small tube.

The dowels shall be secured into clean, dry holes with adhesive. No adhesive shall be used to bond stones at joints unless agreed otherwise with Engineer. The pins shall be cut to size prior to the injection of the resin and shall not be closer than 6mm to the surface for small diameters and 12mm for large diameters.

The resulting holes shall then be filled with matching mortar.

9.18 NUMBERING OF STONEWORK THAT IS TEMPORARILY REMOVED

Using methods and materials approved by the Engineer, number existing unstable stone cladding/facing as directed by the Engineer, and to the specifications listed below. The numbering methodology to be employed shall be determined by the Engineer. Copies of photos and photographic records shall be handed to the Engineer as part of the building file to be compiled by the contractor for this project as detailed in this document.

Carefully dismantle sections of the outer leaf, previously numbered one area at a time, taking care to adequately prop surrounding stone work. Extents of masonry work to be dismantled shall be determined by the Engineer.

Carefully, taking care not to damage the stonework by chipping, etc., store dismantled outer leaf on timber palettes. Care should be taken to ensure that dismantled stonework is not damaged and the original patina of the stone shall be respected. Expanded polystyrene sheets or any other similar material approved by the Engineer shall be used to pack dismantled stone work on timber palettes for future use.

Following the dismantling of the outer wall any unstable stone, material etc shall be removed and the exposed surface shall be prepared for the re-instatement of the previously removed

outer leaf. The dismantled stone work will then be reinstated in their original location and with the same orientation as was originally. Any deteriorated stonework will be replaced with new stone having similar dimensions and configuration. The masonry to be replaced must be approved by the Engineer..

Where necessary, joints at the back of the stone work shall be prepared ready to receive chemical anchors/ties. An average of two ties/ anchors per meter run shall be introduced in every course, or as otherwise directed by the Engineer. While carefully taking care to propagate the minimum vibration possible, drill holes in stonework ready to receive chemical ties/anchors. Ties/anchors shall be sunk to a minimum of 150mm or as specified by the manufacturer into a sound stone fabric. Grout ties/anchor using a suitable epoxy resin, or any other material as directed by Supervisor and civil engineer on site. When inserting ties/anchors, care should be taken to ensure that these are fixed at a suitable inclination as directed by the Engineer to ensure that the newly re-instated stonework is well anchored in the backing material.

The bedding surfaces of the masonry blocks shall be dampened with water as specified in this document. The masonry blocks shall be laid on an evenly buttered bed of mortar prepared from a mixture of suitably slaked air lime and stone dust. Care should be taken to ensure that the exposed surfaces of the masonry blocks are kept clean.

Tie stone blocks together by forming joints, as detailed by the Engineer, and grout using a suitable hydraulic lime based mix, or otherwise, as directed by the Engineer.

Using a hydraulic lime-based grout, grout any interstices between newly re-instated leaf and the original fabric. Grouting should be carried out at course height intervals.

9.19 CLEANING: GENERAL CONSIDERATIONS

The cleaning method adopted should, as far as possible;

- Be effective in removing the deleterious substances from the stone surface.
- Not produce any substances which will encourage any future deterioration of the stone.
- Be slow enough such as to allow good control by the operator.
- Must not cause any micro-fractures or any other discontinuities of the stone surface, as these may initiate or encourage new deterioration processes.

Abrasives, chemicals, or high pressure water jetting will not be permitted. A controlled nebulous pulsating water spray system should preferably be used. The process must ensure that no over saturation and softening of the stone occurs. In those areas where this system is not sufficient to reach the required level of cleanliness, controlled micro-blasting on plain, non-decorative areas may be considered. Systems adopting sand, gravel, or water blasting techniques will not be considered.

Micro-blasting systems used shall be such as to function effectively at low pressure, and use low quantities of water. The abrasive material used shall be calcium carbonate having size and configuration which will not damage the surface texture of the stone fabric.

It is important that any water used throughout the cleaning operation be free from salts. No chemical agents will be permitted. The use of tap water will **NOT** be permitted.

The aim of the cleaning exercise should primarily be that of cleaning the face of the stone and removing all accumulation of carbon, sulphurous compounds, and other contaminants, but should retain the patina of time. On completion of works, the stone is to be brought to its natural patina, texture and profile. All discoloration is to be removed from the face of the stone. No original carved relief arises or surface textures are to be damaged or altered.

Contractor shall ensure that all electrical supplies serving external equipment have been disconnected and that, unless specified otherwise, fittings and associated cable have been removed.

9.20 TESTS TO BE CARRIED OUT DURING THE CLEANING PROCEDURE

The Contractor might be asked to carry out tests to determine the extent of salts within the masonry fabric during and after the cleaning process has been completed. The contractor shall furnish the Engineer with the results of the tests.

9.21 TRIAL CLEANING

The Contractor is to prepare trial samples for all cleaning methods in locations agreed with the Engineer.

The Contractor shall inform the Engineer before carrying out each trial cleaning method to enable the Engineer to approve of selected testing area and be present during the preparation and execution of trial samples. The period of notice shall be agreed with the Engineer.

The time, date, location, details of the all products and procedures for each sample shall be submitted in writing to the Engineer. The contractor shall provide the Engineer with a copy of trial sample records.

9.22 MONITORING

The Contractor shall regularly monitor effects of each cleaning procedure against the degree of cleaning established by approved trial sample/s.

The Contractor shall seek instructions immediately wherever:

- Disruption to the surface occurs;
- Discoloration or stains are revealed by cleaning;
- Anticipated level of surface cleaning is not being achieved.

9.23 BRUSHING BY HAND

Prior to commencing any cleaning method, the Contractor shall remove loosely adhered deposits and growths using suitable corrosion resistant brushes and micro scalpels that do not damage the stone surface.

The use of brushes with steel bristles shall not be permitted. Nylon brushes will be preferred.

Carefully dry brush, one section at a time, using a stiff bristle/nylon brush, dirt from stonework and lime renders to be retained. Care should be taken to ensure that no damage is caused to friable, delaminated stonework. If so deemed necessary such areas shall be pre-consolidated adopting procedures outlined hereunder.

9.24 WATER CLEANING BY HAND HELD SYSTEMS

General cleaning shall be carried out by means of low pressure washing (less than 2 bar) using and hand held mineral/nylon fibre brushes as directed and approved by the Engineer.

Chlorinated mains water shall not be used.

In the process, care shall be taken to ensure no damage is caused to mortar joints.

Stubborn deposits shall be removed first. Softened deposits shall be removed with suitable brushes that do not damage the surface. Any debris shall be thoroughly rinsed.

The Contractor shall seek the prior approval of the Engineer prior to making any changes to the agreed cleaning process.

9.25 LOW PRESSURE CLEANING

Low pressure micro blasting cleaning with pressures not exceeding 3 Bar. The water used shall be free of salts and as specified in this document.

High pressure blasting or washing using pressures in excess of 3 Bar will not be allowed.

The Contractor shall ensure that any water resulting from this cleaning process is not allowed to flow in the streets.

The Contractor shall take all the necessary measures to ensure that cleaning agent or residues are not allowed to stray onto adjacent or protected surfaces.

The Contractor shall ensure that the grit used in the cleaning process is weaker than the stone being cleaned. No cleaning shall commence prior to the approval of the Engineer.

The Contractor shall clean, collect and safely dispose of all debris from scaffolding, ledges, etc at the end of each day.

The Contractor shall prevent marking of cleaned areas from dirt and debris splashing up from scaffold boards.

All cleaning shall commence at the uppermost section of the structure to avoid washing dirt onto previously cleaned surfaces.

Approved cleaning procedures or materials shall not be modified without approval of the Engineer. The Contractor shall seek approval from the Engineer should it be necessary to take additional measures for cleaning.

9.26 WATER SPRAY CLEANING WITH MOUNTED NOZZLES

Water spray cleaning with mounted nozzles shall be used in areas which require a prolonged period of wetting, as approved by the Engineer. The wetting shall last for a period sufficient to produce swelling of the layer of dirt and in combination with small brushes to cut down the saturation period, and shall be attached to a length of pipe connected to the approved water supply. Water to be used must be according to that specified in this document.

The spray shall be atomised from fine nozzles situated at least 300mm away from the masonry. Enough water pressure and small enough orifices shall be required to atomise the water.

The equipment shall be of a type which allows the position and direction of nozzles to be readily adjusted relative to existent surfaces and profiles.

For each surface, the nozzle positions and spraying cycles that enable deposits to be removed/softened whilst keeping the water running off the surface to a minimum shall be established.

The nozzle positions and spraying cycles that enable deposits to be removed/ softened whilst keeping the water running off the surface to a minimum shall be established. The flows will be directed from the top downwards so that the trickling of water softens the lower areas of the dirt build up.

Regular monitoring and adjustment of the washing cycle and nozzle positions shall be ensured by the Contractor as work proceeds; in addition, water spray/ mist shall be controlled by adequate sheeting which shall reduce the effect of draughts of air blowing away the water from the building, since the effectiveness depends on how successfully the mist can be contained.

The heaviest deposits shall be removed first; softened deposits shall be removed with suitable brushes that do not abrade the surfaces. Any debris shall be thoroughly rinsed.

The water spray technique shall not be allowed in severely damaged areas.

9.27 CLEANING OF ORGANIC GROWTH

Surface soiling, by organic growth, shall be initially removed by simple dry bristle knife blades and spatulas, provided that the substrate is sound enough, without damaging or abrading the surface and as approved by the Engineer. If the surface below the growth is delicate or liable to be marked or scoured in any way, this preparation must be limited to removal of higher plants only, and approved by the Engineer.

The application of mild biocides that have a long-term inhibiting effect on re-colonisation shall follow the initial removal of organic growth.

Products to be used shall be neutral products belonging to the chemical class of compounds methoxytriazine, acting by being absorbed both through the roots and the leaves and have a wide spectrum of action; other products include quaternary-ammonium compounds, or as per the Engineer’s approval.

The biocides shall be applied in strict accordance with the manufacturer's recommendations for safety and protection of the workers and the environment. Treated areas shall be brushed with a suitable nylon brush after a period of 7 days or as recommended by manufacturer, following the application of the biocide to remove the dead growth. Procedure shall be repeated to affected areas until biological growth has been removed. Where so deemed necessary, thick layers of biological growth shall be removed using delicate manual methods and hand tools, primarily scalpels prior to the application of the specified biocide.

The general removal of organic growth such as fungus, lichens and the like will be limited to places where these are possibly causing harm and as approved by the Engineer.

In an exceptionally dry period, and in areas where it is recommended to remove the organic growth, dormant dry lichens shall be revived with light water spraying prior to the application of the biocide. Application of biocide treatments will not be undertaken during wet weather or when windy conditions lead to excessive drift of spray.

The Contractor shall protect all surfaces that are excluded from chemical cleaning. All chemical agents shall be contained within each treatment area.

9.28 REMOVAL OF HIGHER FORMS OF VEGETATION

The Contractor shall cut out a metre section of the main stem, around 300mm to 1m above ground level; care must be taken not to damage the adjacent masonry.

After the removal of almost all aerial parts of bushes and trees, chemical spot spraying shall be carried out on cut ends of stems and branches for perennial woody plants and on new buds and leaves in deciduous trees.

Systemic herbicides will be used with absorption through leaves or barks.

A procedure combining mechanical and cleaning means will follow to remove the plants completely.

9.29 CLEANING OF PAINT

Oil Based paints may be removed by a neutral paint remover certified to contain no salts or any other deleterious agent. Repeated applications in paste form may be necessary to remove persistent stains. The pasty, solvent free remover for mineral surfaces will be applied in a thick layer left in contact with the paint for long enough to cause softening and to enable scraping and brushing to take place successfully: the layer will be covered by a thin layer of plastic (as per manufacture's recommended procedure).

Following this application the surface will then be washed thoroughly with warm water and neutral pH soap.

9.30 CHEMICAL CLEANING BY LIQUID GELS

For each area/surface, the lowest possible concentration of agent/s and the shortest dwell times are established. The Contractor is to keep written records of concentrations, dwell times, number of applications, ambient temperatures and rinsing water temperatures.

The Contractor shall ensure that the chemical agents and rinsing water/sprays are contained within each treatment area and, agents or rinsing water/sprays, do not come in contact with surfaces that are either excluded from the cleaning or that have already been cleaned. It is important to prevent wind drift.

Before each application of agent, the surface and adjacent areas are wetted using clean water applied by a low-pressure spray. The wet surface is also tested for pH. The cleaning agent is then applied evenly over the surface and is not allowed to dry out.

The treated surfaces are then rinsed thoroughly and evenly with clean water working from the top of each area downwards. Water spray pressures that will drive cleaning agent into, or cause disruption of, the surface material and joints, will not be used.

PH testing and neutralisation procedures will then follow.

9.31 POULTICES: GENERAL CONSIDERATIONS

The principle behind poultice treatment is that once soiling is dissolved, dirt is held in contact with the pack, rather than dissolved and permitted to fill the pores. The intimate and extended contact of the cleaning materials means that smaller quantities and lower concentrations of chemicals need be used.

The use of the AB57 (Mora Pack) with paper pulp/ cellulose and/ or sepiolite clay is being requested.

The Mora Pack is a mild chemical pack containing agents which facilitate the dissolution of calcium salts.
The poultice shall be prepared by mixing:

- 60g sodium bicarbonate;
- 60g ammonium bicarbonate;
- 25g ethylene diamine tetra acetic acid (EDTA);
- 10g surfactant disinfectant (neutral);
- 60g sepiolite clay/ paper pulp/ carboxymethylcellulose (CMC).
- Water as specified in Section C of this document as required. Tap water or water containing salts will not be permitted.

The above-mentioned ratios may be revised/ adapted by the Engineer as so deemed necessary. The mix is then suitably ironed to a thickness of 4 to 5mm on the pre-wetted soiled surface, and covered with a polyethylene film to prevent the poultice from drying up. The poultice is left in place for a contact period as considered necessary by the Engineer, after which it is gently removed and the treated area rinsed with water as specified in this document and brushed with a suitable nylon brush.

9.32 CHEMICAL CLEANING – POULTICES REMOVERS FOR IRON STAINS

The clay pack for iron stains shall consist of Sepiolite clay and / or paper pulp added to a solution of glycerine, generally sodium citrate. The paste shall then be applied to the stain surface and left to dry.

The paste shall then be removed with wooden or other non-metallic spatula. Several coatings might be necessary to lighten the stain; for stubborn stains, the surfaces shall be wetted. When lifted off, the surface is washed with copious amounts of water.

Given the nature of the crust, this process shall be repeated for as many times as so deemed necessary, until the black crust formation has been removed, and a satisfactory level of cleaning is obtained.

9.33 CHEMICAL CLEANING – REMOVERS FOR GRAFFITI / AEROSOL PAINT

The pasty, solvent-free remover for mineral surfaces shall be applied in a thick layer left in contact with the paint for long enough to cause softening and to enable scraping and brushing to take place successfully; the layer shall be covered by a thin layer of plastic (as per manufacturer's recommended procedure).

Following this application, the surface shall then be washed thoroughly with warm water and neutral pH soap.

Given the nature of the crust, this process shall be repeated for as many times as so deemed necessary, until the black crust formation has been removed, and a satisfactory level of cleaning is obtained.

9.34 CHEMICAL CLEANING – SOAP / DETERGENTS

The Contractor shall apply a non-foaming soap blend for water rinsing and completion of the cleaning.

The lowest possible concentration of agent and the shortest dwell times shall be established for all areas and surfaces.

The Contractor shall keep written records of concentrations, dwell times, thickness and number of applications. Powdered detergents shall not be used.

Given the nature of the crust, this process shall be repeated for as many times as so deemed necessary, until the black crust formation has been removed, and a satisfactory level of cleaning is obtained.

9.35 CONSOLIDATION

Stone consolidants are applied to the stone fabric as liquids, depositing a solid material within the pore structure of the material.

The main function of a stone consolidant should be that of restoring the cohesion, physical properties and appearance of the deteriorated stone. It is thus important that the choice of a suitable consolidant should be based on the following parameters:

- Consolidating value, whereby the treated deteriorated stone recovers its original properties, mainly strength, surface hardness and abrasion resistance.
- Durability
- Depth of penetration, affected mainly by the viscosity and surface tension, rate of gel or precipitation formation, method and conditions of application, and rate of evaporation.
- Stone porosity. As the proportion of fine pores increases, the stone becomes more susceptible to salt attack. The consolidant should, ideally not alter the pore size distribution of the original material.
- Moisture transfer
- Compatibility. Cured stone should have three-dimensional properties similar to that of the original stone. Consolidants should not form by-products containing harmful salts that can cause further damage to the stone.
- Appearance of the consolidated stone.

The consolidants to be used shall be non toxic and of a one component system, having a silicium organic compound base (70 to 80%). They shall be thin, and have a low viscosity of 3.3c ST at 25oC or better, certified to penetrate deep into fine capillaries. They shall not impair the breathability of the stone structure, be durable and resistant to local weather. The consolidant used shall be colourless, have a density in the region of 0.96 to 0.98 g/ cm3, or better, and cure without any salt formation. The consolidant shall be catalysed by atmospheric humidity. The consolidant shall be applied to specifications detailed by the manufacturer. It shall not be applied to stone subjected to high moisture content, or characterised by an elevated salt content. Ideally, the stone is to be consolidated by flooding either by a coarse-droplet, or preferably by a long-bristled brush.

The consolidant shall be applied generously and uniformly to the stone surface, until the stone surface is saturated. If so considered necessary, the Engineer and Civil Engineer in charge may request that this exercise be repeated for as many times as so deemed necessary. For payment reasons, this exercise will be considered as an intrinsic part of the consolidation exercise, and in no case will the contractor be allowed to make claims for extra costs in relation to workmanship, and/ or material.

The consolidant shall not be applied in windy or elevated climatic temperature conditions which would impair the penetration of the same material. Consolidated areas should be protected from water, wind, and other natural/ man-invoked adverse conditions for a minimum of 30 days, or more if so specified by manufacturer.

9.36 CONSOLIDATION: DELAMINATED STONEWORK

In cases where the extent of delamination is such that the layers of stone have become detached, the space resulting between the layers shall be suitably cleaned prior to the application of the consolidant. Cleaning shall be carried out by low pressure air, conveyed through pipes adequately sized to reach the interstices followed by the liberal application of an approved volatile solvent such as acetone. Using suitable methods designed to ensure deep

penetration, apply a consolidant within the interstices and cure for a minimum of thirty (30) days, ready to receive lime injection.

The consolidant shall not be applied in windy or elevated climatic temperature conditions which would impair the penetration of the same material. Consolidated areas should be protected from water, wind, and other natural/ man-invoked adverse conditions for a minimum of 30 days, or more if so specified by manufacturer.

Using a fluid lime mortar, suitably prepared to specifications listed in this document, inject in interstices previously consolidated. When injecting, care shall be taken to ensure pressure exerted on delaminated stone sections does not cause shearing of the same material. In cases where the detached material is of considerate dimension, carbon fibre rods, bridging the weaker layers with the strong fabric, and grouted with the same fluid lime-based mortar shall be introduced. Glass reinforced polyester resin and/or carbon fibre rods shall be inserted such as to be least intrusive.

Using epoxy resins a specified hereunder, having suitable characteristics and viscosity, inject, under pressure, cracked masonry sections previously consolidated. Epoxy Injection will be resorted to only for areas where injected fluid lime mortar would be inadequate.

9.37 MORTAR REPAIR OF CRACKS

Mortar injection of cracks shall be carried out with proprietary fluid lime based mortar as specified in this document.

When injecting, care shall be taken to ensure pressure exerted on delaminated stone sections does not cause the shearing of the same material.

In cases where the detached material is of considerate dimension, carbon fibre rods, bridging the weaker layers with the stronger fabric, and grouted with the same fluid lime-based mortar shall be introduced. Carbon fibre rods shall be inserted such as to be least obtrusive.

9.38 LIME INJECTION MORTARS

The injection mortars used shall be suitably prepared from good quality and chemically stable hydraulic lime, free from salts, pozzolans and other inert additives, mixed into a consistent thixotropic, injectable putty.

Prior to injection, all stone surfaces should be desalinated, adequately consolidated, cleaned from any accumulated dirt/dust and suitably wetted with water as specified in this document. Mortar shall be injected into the crevices using suitably sized syringes. Application should not be permitted in ambient temperatures exceeding 30ºC.

The injection mortar used shall have a specific weight of 1200kg/m3, an initial set of an average of six (6) hours, and a final set of approximately ten (10) hours, attaining a mean compressive strength of 26 N/mm2, and an average flexural resistance of 7N/mm2 after 28 days. The set mortar shall attain an elastic modulus of 15 (+/- 1.5) N/mm2, and a change in dimension not exceeding 1.60μm.

9.39 EPOXY RESIN INJECTION

Epoxy resins as specified in this document, having suitable characteristics and viscosity, shall be used for the injection, under pressure, of cracked masonry sections previously consolidated.

Epoxy injection will be resorted to only for areas where injected fluid lime mortar would be inadequate

The epoxy resin used shall be a solvent-free resin-based product supplied in two packs (resin + hardener), having a low viscosity, and certified by manufacturer to suitably fill cracks in the region of 1mm or more as so required. The resin shall be certified by manufacturer to have a suitable bonding to masonry, be colourless (or have a stone colour), be resistant to chemicals, and have an effective adhesion even on moist masonry surfaces. The material shall be easily injected into the crack structure using proprietary methods and tools, including suitably sized non-return injection valves. It shall have a compressive strength greater than 60N/mm2, and a flexural tensile strength of more than 30N/mm2.

All masonry surfaces to be treated with epoxy resins shall be clean, free from any loose material, greasy substances, etc. Cracks should be superficially sealed with an epoxy resin having suitable viscosity, and proprietary injection nozzles fixed. Following the injection of the epoxy resin, and after allowing sufficient time to ensure that the structural stability of the delaminated or otherwise masonry structure is restored, the masonry is carefully cleaned from the superficial epoxy resin applied previously to seal cracks.

9.40 GROUTING

The Engineer may request grouting of voids resulting between new and old masonry, displaced masonry, etc with an organic material such as hydrated or hydraulic lime. The lime grout shall be prepared with or without filler depending on the size of the gap.

Glass reinforced polyester, epoxy or stainless steel ties shall be used as and where directed by the Engineer.

Grouting holes shall be formed in joints at suitable horizontal and vertical centres to suit coursing and achieve an effective distribution of grout and fill all voids, as per the Engineer’s approval.

The maximum length of each lift between pours shall be established to prevent any disturbance of the masonry.

Unless re-pointing precedes grouting, the joint shall be sealed as necessary on either side of the grouting holes with an approved temporary material to prevent leaking of grout. The temporary seal shall be kept back from the face work to allow for specified re-pointing.

Before grouting, the delivery holes shall be thoroughly flushed with clean water.

Site trials, in all areas indicated by the Engineer, shall be carried out for the different methods of grouting so as to establish the parameters required to achieve uniform grouting.

9.41 GROUTING BY HAND

The grout material shall be poured under gravity into the interstices formed by the masonry structure.

9.42 GROUTING BY GRAVITY INJECTION

The approved equipment shall include a control of grout flow at the head of the hose (plug) and at the delivery nozzle (stop valve).

The height of the pan above delivery nozzle (subject to site trials) shall be sufficient to ensure an adequate flow, usually around 4.5m.

9.43 PUMPED INJECTION GROUTING

The delivery pressure shall be established after site trials.

9.44 CAPPING (WHERE APPLICABLE)

From a mere visual inspection it results that the exposed topmost face of the exterior walls, are well sealed off by the type of construction methodology employed. In the latter case the issue of sealing off the exposed top level will be vital, as water ingress into the infill layer can cause bulging of the wall and overall destabilization.

The top of the ruins are to be capped where indicated by the Engineer. The capping mix will consist of a mix 2 parts of brick dust, 1 part hydraulic lime and 1 part sand. The *brick dust* used will be a pre-mix. The hydraulic lime will be either white or brown in colour, depending on the colour to be achieved on site. A sample patch should be made for the Engineer to establish the adequate colour.

Method of application:

- Wet the area of application thoroughly beforehand. If this is applied during the summer months, special care should be given in keeping the area thoroughly wet during application.
- Put a layer of sand over the said area. The use of sand depends on the density required.
- Compact this layer properly with hand held tools.
- Wet the sand.
- Place the brick dust pre-mix.
- Compact thoroughly with hand held tools
- Fresh areas of *brick dust* shall be shaded from direct sunshine and/or sheltered from continuous rain and cured adequately.

Since the compaction will occur on the topside of the wall and within a restricted width, any compaction will be carried out with hand held tools/equipment and no excessive vibrations shall be caused that will disturb the stability of the wall.

10. CONCRETE WORKS

10.1 GENERAL OUTLINE OF WORKS

The grade of the concrete shall be as specified by the Engineer and Civil Engineer in charge.

10.2 CEMENT

Portland cement conforming to EN 197-1:2000 or equivalent shall be used.

Stacked cement shall be stored in a dry, well ventilated place with boarded floors. Cement shall moreover be of the brand approved by the Engineer and Civil Engineer in charge. Tests of cement shall be made at the discretion of the Engineer in charge and any cement below the standard required will have to be replaced by the contractor. Partially set or damaged cement shall not be used in concrete works.

10.3 AGGREGATES

Coarse aggregates shall consist of first quality crushed hard stone passing a 19.05mm mesh sieve, graded according to EN 12620:2002 or equivalent and EN 933 or equivalent.

Sand or fine aggregate are to be clean, sharp and gritted and free from loamy matter and other deleterious substance. They shall pass a 9.5mm mesh sieve and be graded according to EN 12620:2002 or equivalent and EN 933 or equivalent. The sand is to be washed and screened when so directed by the Engineer in charge at the expense of the Contractor.

10.4 WATER

Clean, fresh water, entirely free from organic matter shall be used. The necessary quantities of water shall be provided by the Contractor at his own expense.

10.5 REINFORCEMENT

10.5.1 Generally

All steel reinforcement for reinforced concrete works supplied and paid for by the Contractor and shall be cut, bent, tied, hoisted and placed in position and kept firmly in place as shown on drawings and/or as indicated by the Engineer in charge. All steel fabric reinforcement shall be in sheets.

Rods showing signs of cracking or brittleness following bending shall not be used in the works. No welding of rods will be permitted, except tack or positional welding between plain mild steel rods crossing approximately at right angles so as to fix them in position. Such welding of high tensile or work-hardened mild steel rods will not be allowed except in fabric to BS 4483:2005 or the equivalent.

Care is to be taken to ensure that the overall depth of slab rods and the overall size of links are accurate, and that the rods are not unwinding after they are bent. All steel reinforcement is to be free from scales and any appreciable rust, oil, paint, mild scale, or coating of any character

which would tend to destroy its' adhesive bond with the concrete. All steel is to conform in all respects to the requirements specified in MSA EN 10080:2005 or equivalent. Mesh reinforcement is to comply with BS 4483:2005 or equivalent. All rods shall be bent cold in accordance with BS 8666:2005 or equivalent. The Engineer shall have the authority to order tests on any steel prior to its being used on the works. Any steel not of the required standard shall be rejected and will have to be replaced by other of approved quality at the Contractor's expense.

When required to do so by the Engineer, the contractor shall provide:
a) the manufacturer's name,
b) the manufacturer's routine work test certificate,
c) ladle analysis

for all the reinforcement supplied.

10.5.2 Bar Reinforcement

Mild steel bar reinforcement shall conform to BS 4449:2005 or the equivalent and shall have a specified characteristic strength of 250 N/mm2.

High yield steel bar reinforcement shall conform in all respects to BS 4449:2005 or the equivalent and shall have a minimum specified characteristic strength of 460 N/mm2.

10.5.3 Fabric Reinforcement

Steel mesh fabric reinforcement shall conform to BS 4483:2005 or equivalent. It shall be used only in sheets and is to be lapped a minimum of 400mm all round.

10.6 FORMWORK

The contractor shall be entirely responsible for the design, erection and safe removal of all necessary shuttering.

Formwork or centring shall be true to line and sufficiently strong to carry the dead weight of wet concrete plus any incidental loading without noticeable deflection. It shall be sufficiently rigid to guard against movement or vibration whilst concrete is being placed and tamped into position. Sheeting shall be close together to prevent leakage of the fine stuff and shall be 'treated' in a way to facilitate striking and obtain a clean release. Formwork for slabs shall be laid with an upward camber to ensure a level ceiling.

All formwork must be carefully cleaned out before any concreting takes place. Faces in contact with concrete shall be free from adhering grout, projecting nails, splits or other defects. The Contractor must make sure that formwork is such to give a reasonable smooth finished face to concrete placed against it.

All formwork must be adequately braced and strutted during the maturing period of the concrete.

10.7 POSITION OF REINFORCEMENT

All fabric reinforcement is to be in sheets and fixed in the required position by metal chairs or some suitable method approved by the Engineer and Civil Engineer in Charge.

Adequate and effective precautions should be taken to leave all reinforcement undisturbed during concreting, planking elevated on low trestles for the passage of wheel-barrows being provided by the Contractor. Wheel-barrows shall under no circumstances be allowed to transit directly over the reinforcement. All reinforcement shall be placed strictly as directed. Nothing shall be allowed to interfere with the required disposition of the reinforcement. The Contractor shall ensure that all parts of the reinforcement are placed correctly in every respect, and are temporarily fixed where necessary to prevent displacement before or during the process of tamping and ramming the concrete in place.

10.8 FIXING OF REINFORCEMENT

Adequate temporary spacers, chairs and binding wire shall be provided to maintain the steel in correct position. Binding wire is to be thoroughly annealed 1.5mm diameter soft wire. These items shall be deemed to be included in the rates for fixing.

Covers to the steel reinforcement shall be properly maintained. Fabric reinforcement shall be lapped 400mm in each direction and tied at 300 mm centres along each joint or as shown on drawings.

On no account is any reinforcement to be left out for inserting into wet concrete during the progress of concreting, and in no case may any portion of the concrete be put in position and allowed to set in order to act as a base upon which to set up any of the reinforcement for the member.

10.9 INSPECTION OF FIXED REINFORCEMENT

When the reinforcement is in position for concreting, the contractor must notify the Engineer in charge who is to arrange for it to be checked before any of it is covered up with concrete. Such checking will not relieve the contractor from any of his/her responsibilities under the contract.

10.10 CONCRETING

All concrete and constituent materials shall comply with the requirements of MSA EN 8500-2:2006 or equivalent.

The materials for the concrete are to be carefully measured in the proper proportions, measuring containers of suitable sizes being provided by the contractor and used for the purpose. The contractor is to obey all directives by the Engineer in Charge concerning the mix.

The mixing of concrete, unless otherwise authorised by the Engineer in Charge, shall be done by batch of approved type, which will ensure a uniform distribution of the materials

throughout the mass so that the mixture is of uniform colour and homogeneous. The entire contents of the drum shall be discharged before recharging. The mixer shall be cleaned at frequent intervals while in use.

The volume of mixed materials shall not exceed the manufacturer's rated capacity of the mixer. The mixing of each batch shall not be less than 1 minute or exceed 10 minutes under normal conditions.

Immediately after mixing, concrete shall be transported to the site and carefully placed around reinforcement bars and thoroughly tamped as to exclude any voids. No more than 30 (thirty) minutes shall elapse between mixing and final placing of the concrete. The concrete shall be discharged from the mixer and transported to the works by means which shall prevent adulteration, segregation or loss of ingredients and so as to ensure that the concrete is of the required workability at the points and time of placing. Segregated concrete will be rejected.

A mechanical vibrator shall be used throughout all Concrete Works.

The re-tampering of the concrete which has commenced to set and re-mixing with or without additional cement, aggregate or water shall not be permitted. Before placing any new concrete against an existing face, this face shall be roughened, cleaned and brushed over with a thick grout of cement. All concrete shall be well cured with water and protected from the sun for four days after placing. The quantity of water used shall be the minimum necessary to produce concrete of the workability required by the Engineer and Civil Engineer. The consistency of the concrete when required by the Engineer shall be measured by the slump test which in no case shall be more than 100mm.

10.11 PLACING OF CONCRETE

The methods of placing concrete shall be to the approval of the engineer in charge. Concrete shall be so placed that contamination, segregation or loss of the constituent materials does not occur.

Concrete is not to be distributed to its final position by means of vibration. Shaking of reinforcement to assist the placing of concrete will not be permitted.

Care must be taken to ensure that any rods which project from set or partially set concrete are not moved or jarred.

Concreting must be carried on continuously up to construction joints. Any construction joints must be carefully arranged in approved positions where they will have the least effect upon the strength of the structure.

10.12 COMPACTION OF CONCRETE

All concrete is to be consolidated by vibration to ensure that the concrete is worked into every interstice between and around the reinforcement so as to ensure a compact mass without voids and of the greatest possible density throughout.

Wherever possible, vibration is to be carried out with immersion vibrators which are to be applied for short duration sufficiently frequent to consolidate the concrete effectively. Points

of vibration are in no case to be further apart than 500mm. Immersion vibrators are to be totally immersed in the concrete and withdrawn slowly. The maximum speed of withdrawal is not to exceed 75mm per second. Vibrators are not to be allowed to rest against, or come into contact with reinforcement or the faces of the formwork.

10.13 REMOVAL OF FORMWORK

Forms or struts for concrete shall not be removed before 15 days or any such period as specified by the Engineer in charge until the concrete is sufficiently strong to safely carry the loads, dead or temporary.

The responsibility for the safety of the concrete will rest entirely on the contractor and he will be held liable for any damage. He will, moreover, be bound to make good same at his own expense.

Immediately after striking formwork, all air holes and other irregularities in the exposed surfaces are to be stopped or otherwise made good with cement and sand mortar mixed in the proportions of 1:3 respectively. The whole finished surface shall be of a reasonably smooth appearance free from voids, holes and bulges.

10.14 CUBE TESTING OF CONCRETE

Any cube tests shall be made in approved 150mm moulds from samples taken in accordance with MSA EN 12390:2000 or equivalent. Samples shall be from every individual pour of concrete irrespective of the volume of concrete pours. A pour is being defined as one continuous concreting operation, i.e. not necessarily one lorry load of concrete.

Each cube shall be marked on its surface without any etching of the surface with a distinguishing number and the date, and a record shall be kept on site giving the following:

- Cube number
- Date made
- Location of work within the site
- Design mix
- Name of person taking sample
- Crushing tests results
- Date
- Strength
- Density
- In the Case of Ready Mix Concrete, the Delivery Note Number.

At least four, preferably six, test cubes from each sample shall be made in approved 150mm moulds, two, preferably three, to be tested at 7 days, and two, preferably three to be tested at 28 days. In each case, the average of the two or three results shall be taken as the test result.

All cubes shall be stored on site in their mould for at least 24 hours, in a place free from vibration, under damp matting and completely covered with polythene. When the concrete has achieve sufficient strength, the cubes shall be de-moulded and immediately submerged in a tank of water until they are taken to the approved independent testing laboratory. No cube shall be dispatched before it is 3 days old. The testing laboratory shall be approved by the

Engineer in charge before the commencement of the concreting operations. One copy of all test cube results shall be forwarded to the Engineer in charge. The concrete in each grade will be considered acceptable if the average of any four consecutive 28 day test results exceeds the specified grade by 3N/sq.mm, and if no individual 28 day test result is less than the specified grade by 3N/sq.mm. The 7 - day test result will be compared to the 7 - day result obtained in the trial mixes, and the Contractor advised of the potential problems in any instances where the test result is more than 2N/sq.mm less than the trial mixes.

The Contractor shall also allow in his rates for concrete, for all expenses in connection with the preparation, conveying to the testing laboratory, and for the testing of the test cubes.

10.15 CURING OF CONCRETE

All reinforced concrete work shall be designed, mixed, placed, compacted and cured in accordance with EN 1992-1-1:2004 or equivalent to the approval of the Engineer in Charge.

Minimum period of curing shall be as indicated in EN 1992-1-1:2004 or equivalent.

Concrete must be protected during hardening from the harmful effects of the weather or running water.

The protection shall be applied immediately after completion of placing, by one or more of the following methods:

- by covering with a layer of sand, sacking, canvas, hessian, straw mats or similar absorbent materials and keeping constantly wet for 72 hours.
- by thoroughly wetting and then covering with a layer of approved waterproofing paper or plastic sheet or insulated mats kept close to the concrete for 72 hours.

10.16 ADMIXTURES

Any admixtures to the concrete mix are to be approved by the Engineer and used strictly in accordance with the manufacturer's instructions.

11. MATERIALS

11.1 WATER

Water to be used shall have conductivity inferior to 60 μS. The contractor is to give a proposal of methodology of testing the water on site. Therefore, a trial should be tried and tested on site on each consignment brought on site. Chlorinated water or tap water shall not be used.

11.2 SAND FOR LIME MORTARS

Sharp, well graded and conforming to the methods of sampling and testing and quality requirements of statutory EN regulations and in particular EN 1097, unless specified otherwise.

11.3 LIME (HYDRAULIC AND AIR LIMES)

Unslaked Lime (quicklime), shall be prepared from suitable, good quality upper coralline limestone. The quicklime should preferably be prepared in a wood-fired kiln in a temperature not exceeding 900ºC. The stone matter should be suitably cooked to prevent under burning, over burning, or sintering of the stone, keeping the contents of any inert residue to the minimum as permitted by established International standards. The quicklime shall be crushed to a fine powder, sieved, packed, and delivered to site in dry conditions, and soon after baking. When testing sample of lime using Hydrochloric acid, the CO2 content of lime supplied shall be in the region of 3%. All lime shall conform to the statutory EN regulations and in particular EN 459.

The hydraulic lime should be natural, free from any additions such as Portland cement, etc., or any other material, which contains any quantity of deleterious salts such as sulphates, chlorides, nitrates, etc. The hydraulic lime offered should be that defined by standard norms as eminently hydraulic lime C3/ XHN 60, though natural cements, class D/ XHN 100 (roman cements), may be used subject to the approval of the Engineer. The hydraulic lime offered shall have an initial putty setting time in water of 2-4 days, acquiring a stone-like consistency following 12months curing in water. Composition of CaO and MgO shall be over 50%, while SiO2, Al2O3, and Fe2O3 shall amount to approximately 12%-25% of active clays. Crushing strength at 28 days of a mixture of 1:3 lime: sand, shall be in the region of 6.00N/mm2. For natural cements, class D, crushing strength at 28 days of a mixture of 1:1 lime: sand, shall be in the region of 10N/mm2. Hydraulic lime used shall have a stone colour, and shall be certified to have been produced at a temperature inferior to 1100ºC. It shall be ground to a fine powder having a specific area of 8000cm2/g.

11.4 LIME (PREPARATION OF AIR LIMES)

Quicklime (unslaked lime) shall be slaked soon after it has been produced.

The slaking shall be carried out in a container of suitable shape and material which will not permit the material to overheat during the slaking process.

Soon after slaking the lime shall be sieved through a 5mm gauge sieve to remove any uncreative material.

The slaked lime putty shall be allowed to mature under water for a minimum period of 4 weeks before being used.

The slaked putty shall then be mixed with the aggregate specified above in ratio of 1 part lime to 3 parts sand is as specified and approved by the Engineer.

11.5 LIMEWASH

Prior to the application of the limewash, the background shall be washed to remove dust and grime, then allowed to dry to a damp state. Any organic growth shall be treated with a suitable biocide as directed by Supervisor and Civil Engineer in charge, and dead material brushed off before applying limewash.

Apply the limewash to the substrate with a long-haired bristle brush, using horizontal, vertical, and diagonal strokes, ensuring the lime wash is applied as thinly and evenly as possible, and is burnished into the surface. Overly heavy coats will craze and crack when they harden and dry. If this occurs, wash off with hot water and a stiff bristle brush and ensure that the new covering is properly applied.

Containers of lime wash should be constantly stirred during application to ensure even distribution of lime and pigment. Allow the first to dry fully before applying the second coat, and so on, lightly dampening the background before applying the next coat. Damping shall ideally be carried out by spraying water to an area of approximately 2 sq. m. at a time. Protect from strong winds and direct sunlight during the drying out period. Limewash shall be produced from mature lime putty mixed with water to a suitable consistency. The mix shall be sieved into a bucket, working through any lumps, but leaving any grit in the sieve. Add colour as directed by Supervisor and Civil Engineer in charge, mix well and sieve again prior to use. It is difficult to match lime colour batches. It is thus ideal that all lime wash provision required be prepared in one batch.

11.6 LIME MORTAR

Lime mortars shall be free from cement and produced in conformity to standards set out in the statutory EN regulation and in particular EN 998 and EN 1015. The density of the lime putty shall range between 1.3 and 1.4kg/l and shall not contain any salts (nitrates, chlorides, sulphates, etc) which contribute towards the deterioration if the stone.

11.7 POZZOLANIC MORTARS

The use of pozzolanic additives such as brick dust, pozzolanic etc to enable air limes to set hydraulically will be permitted. However care shall be taken to ensure that pozzolanic (natural or artificial) added are not toxic and do not contribute towards the deteriorations of stone. Pozzolanic such as polverised fuel ash or others which contain salts detrimental to the stone will not be allowed.

Any pozzolana shall be added to the mortar before use.

11.8 BRICK DUST

Brick dust used shall be prepared from good quality red (terracotta) clay baked to a temperature between 850ºC and 900ºC. Clay baked at higher or lower temperatures **shall not** be used for the production of brick dust.

The brick dust used shall be clean and free from deleterious substances, etc., The baked clay shall be crushed and adequately graded for use as specified in this document.

The use of glazed ware for the production of brick dust will not be permitted.

11.9 HIGH LOAD DAMP PROOFING MEMBRANE

The high load damp proof membrane shall be a pitch polymer DPC ideal for damp proofing of walls in stone and bricks, capable of taking high loadings.

It shall be capable of being used both in vertical, horizontal and cavity tray positions.

It shall have a nominal thickness of not less than 1.25mm.

11.10 LIQUID MEMBRANE

The liquid membrane shall consist of a thixotropic polymer based high resistance liquid, resistant to UV rays, to take foot traffic and with excellent adhesion to concrete and masonry surfaces.

The liquid membrane used shall be stone colour unless otherwise requested by the Engineer and Civil Engineer in charge.

Application shall comply strictly with manufacturer’s instructions.

11.11 STAINLESS STEEL

All stainless steel used for this project shall, unless otherwise instructed by the Engineer to be Grade 316, or better, certified for use in marine environments as specified in EN 10088-1:2005, or its updated version.

11.12 MICRO FIBRE STRANDS

Fibre strands used to reinforce concrete shall be polymer-based, certified by the manufacturer as suitable for the nature of works described in tender document. They shall be such as to prevent shrinkage crack formation, withstand corrosion and be resistant to alkalis and acids. Fiber diameter shall be in the range of 17 to 20 microns, and having a specific density ranging between 870 and 930kg/ cu.mj. They shall have a tensile strength in the region of 390 to 500Mpa. Max elongation at break point shall not exceed 14%. A minimum of 0.85kg of these fibre strands or as recommended by manufacturer shall be mixed with one cu.m of mortar mixed.

11.13 EPOXY RESINS

The epoxy resin used shall be a solvent-free resin-based product supplied in two packs (resin + hardener), having a low viscosity, and certified by manufacturer to suitably fill cracks in the region of 1mm or more as so required. The resin shall be certified by manufacturer to have a suitable bonding to masonry, be colourless (or have a stone colour), be resistant to chemicals, and have an effective adhesion even on moist masonry surfaces. The material shall be easily injected into the crack structure using proprietary methods and tools, including suitably sized non-return injection valves. It shall have a compressive strength greater than 60N/mm2, and a flexural tensile strength of more than 30N/mm2.

All masonry surfaces to be treated with epoxy resins shall be clean, free from any loose material, greasy substances, etc. Cracks should be superficially sealed with an epoxy resin having suitable viscosity, and proprietary injection nozzles fixed. Following the injection of the epoxy resin, and after allowing sufficient time to ensure that the structural stability of the delaminated or otherwise masonry structure is restored, the masonry is carefully cleaned from the superficial epoxy resin applied previously to seal cracks.

12. MONITORING AND DOCUMENTATION

12.1 INSPECTION BY THE ENGINEER

Prior to the dismantling of any scaffolding, the contractor shall give the Engineer sufficient time to inspect all the works. The contractor shall give the Engineer at least one week notice to allow for a final inspection.

The contractor shall be responsible for the clearing of all apertures, ledges, window sills, etc from any material resulting from any of the processes outlined with this document.

12.2 DEFECTIVE WORK AND MATERIALS

All rejected work shall be removed and replaced using new materials at the Contractor’s expense. The Contractor shall also be bound to replace any defective materials in all or parts of the existing Works by proper materials and/or workmanship as directed by the Engineer. The Contractor is liable for the restoration works and restoration interventions specified in this tender document.

12.3 DOCUMENTATION OF RESTORATION INTERVENTIONS

The contractor shall, on completion of works on each section, and prior to certification of works, submit to the Engineer a drawing accurately indicating all interventions carried out. This documentation shall form part of the building file to be submitted to the Engineer on completion of works.

The contractor shall be responsible to map every intervention carried out so as to provide a detailed record of works. Distinct interventions (stone replacement, consolidation, etc) shall be mapped on a separate layer allowing the user to view each intervention separately. The mapping shall be carried on a stone-by- stone basis and the exact demarcation of each intervention shall be denoted by a closed polygon and hatched as detailed by the Engineer.

Prior to the certification of works the contractor shall submit to the Engineer two printed copies (in colour) in scale 1:100 or as requested by the Engineer and a digital copy (AUTOCAD 2006 compatible). The drawings and mapping indicated shall be certified by a warranted Supervisor and civil engineer specialized in restoration, as exactly representing the works (type and extent) carried out.

12.4 PHOTOGRAPHIC RECORD OF RESTORATION INTERVENTIONS

The contractor shall, on completion of works on each section, and prior to certification of works, submit to the Engineer a set of photographs indicating all interventions carried out. This documentation shall form part of the building file to be submitted to the Engineer on completion of works.

The photographs shall clearly illustrate the interventions carried out as well as the state of the structures to be restored prior to the commencement of works. Any archaeological, historical, etc. evidence such as masons marks, particular construction details, etc. discovered on site during the progress of works shall also be documented.
The photographs shall be submitted to the Engineer prior to the certification of works. The photographs shall be submitted in digital format saved on a CD (Compact Disk) or DVD as directed and approved by the Engineer.

The photographs shall be taken with a high resolution colour digital camera, saved in .jpg format and not less than 3.2Mb in size.

All photographs shall be taken with adequate lighting (flash light should as far as practicable be avoided) and should be of a good quality free from blurs and colour bleeding.

13. SAMPLES AND TESTS

13.1 TESTS TO BE CARRIED OUT

Prior to commencement of works the contractor shall carry out the following samples as directed by the Architect:

- Cleaning technique decided upon by the Architect;
- Pointing;
- Pumped injection grouting;
- Biocide;
- Micro Blasting (if necessary);

13.2 CHEMICAL ANALYSIS OF WATER

The Contractor shall test the pH value of clean water used for all techniques used within this contract, and all chemical agents to be used in the cleaning processes before application.

All solutions shall be thoroughly mixed before taking a sample for pH measurement.

All readings shall be carried out at the same temperature, or compensated for if taken at different temperatures. All data shall be submitted in writing to the Architect.

13.3 STONE SAMPLES TO BE PROVIDED

Also prior to stone/stair replacement the contractor will be asked to provide the following:

- Local stone for flooring.

A minimum of three test samples per test is required. After samples are prepared and cured they will be tested (7days and 28days) for the above tests.

13.4 PRELIMINARY INVESTIGATIONS BEFORE RESTORATION AND CONSERVATION WORKS

13.4.1 General Issues

The preliminary investigations before restoration and conservation works will have the aim to acquire a more extensive knowledge regarding the construction former characters of the building on which the works have to be carried out. Such investigations will aim to the analytical and scientific acquiring of data and information regarding the real nature of the material used and its state of conservation, in order to complete and check the knowledge framework of the decay considered as base for the design.

Any type of investigation, also the ones already foreseen during the design phase, will be discussed and approved by the responsible of the works. The Contractor will carry out the shared cycle of survey following the arrangements received, respecting the building characteristics, and prior the authorization of the authorities charged.

Before starting any type of works, the Contractor will carry out the knowledge investigation always preferring that ones that do not destroy the materials and/or the building elements, in order to make no prejudice to the building conservation, having particular care to not alter the former conditions.

13.5 INVESTIGATION TYPOLOGIES

The investigations could interest various materials, such as stones, plasters and mortars, woods, metals, concrete and coverings; and could be carried out according to various deepening levels, such as:

- direct visual inspection;
- chemical analysis;
- physical analysis;
- biologic analysis;
- mechanical analysis.

13.5.1 Not Destructive Tests

The not destructive tests will be carried out “in situ” without any material withdrawal. Some examples are: direct survey, photographic and topographic tele-survey, termography, magnetometry, colorimetry, sonic and ultrasonic survey, lightning survey, radar and geo-radar survey, etc.

13.5.2 Light Destructive Tests

They will be carried out by the withdrawal of small material fragments taken from decaying portions or making small holes.

13.5.3 Destructive Tests

In some case they are needed in order to monitor the inner state of some building elements and their resistance.

13.6 PROCEDURES TO EXECUTE THE INVESTIGATIONS

In order to execute the investigations, the Contractor will use tools and devices able to guarantee the perfect desirable result.

The investigations have to be executed by specialised personnel and, if considered needed, the Contractor can be supported by specialized and recognised institutions or laboratories.

After finishing the investigation works, the Contractor will restore and clean the site, eliminating any not convenient working residual.

The photogrammetric and topographic surveys and all the surface tele-survey systems will be carried out through suitable devices; furthermore, they will be comprehensive of the processing, the graphic drawings and the analytic and photographic description, including also comments on the results acquired in order to create a correct interpretation of the information related the on-site state.