Problems in the history of bastioned fortifications. Methods of restoration and rehabilitation of the bastioned fortifications with earthen rampart.

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Abstract: The bastion-shape fortifications represent a particular domain of the engineering which has flourish over the past centuries and it is closely connected with the architecture, military methods and also many other domains of science. Today the bastioned fortifications in Europe are in a great danger. It is no longer a problem linked with the means of conservation of this historic relics for posterity, who are threaten with destruction, even before the experts can study them, but also this matter represent a problem of sustainability of this structures, and the way this structures can or can’t be integrated inside the urban structure of the 21st century modern cities. Since the bastioned fortifications were different from the incipient forms, their investigations require different methods of research. To conclude this shortly, this methods contain a study of their historical past (including a brief review of the history of fortifications), and also an analysis of the site where the defensive structure lays from the point of view of defence with an particular accent over the adjacent surroundings and the perimeter. The analysis of the fortification itself contain a deep study over the profile (vertical section) of the rampart and the ditch and finding the “line” of the fortress trace, in order to establish the type of the measurement unit which was used when the plan was traced ,when the fortification was built. Next stage is the calculation of the geometric proportions and the angles of the original outline of the elements (having as basis geometric rules with the characteristic proportions), then follow the analysis of the structures from the inside of the outline, communications, accesses and the exterior buildings. This paper relates to the direct way of the restoration and rehabilitation of the Cluj Citadel.

Key-Words: - Military Architecture Theory, Fortifications, bastioned fortress, rampart, bastion, artillery, Vauban.

1 Introduction
Dealing with the bastioned fortifications was always a problem. The main problem was how you use them after their military function stopped. The second issue is what you do with them after, how you restore them, how you rehabilitate them, and most important is how you make them a sustainable long-time project. One of the most important, and hard challenge is the restoration process, sometime the most costly also. Restoring an earthen fortification is different from the other types. This paper propose a set of 10 steps (stages) of intervention when dealing with such cases of structures. Each stage is deeply analysed in order to extract the main features of the restoration process. The subject of this study is a case-study: Cluj Citadel, a small earthen fortification on one the Cluj hills.
2 Methods of restoration and rehabilitation of the bastioned fortification with earthen rampart.

Fig.1                             Fig.2
Fig 1,2-research stage I: Site analysis.

The research program was carried out in order to study the way we can rehabilitate, restore and include in the fortress remains in the modern urban space within the old historic neighbourhood of the city. For this reason has been study theoretical and practical models (2 other cases) with common features like Cluj. The analysis has been made having as basis the historical maps of the citadel, reconstruction of some important stages in the history of the citadel. It has been demonstrated in this study the membership of Cluj citadel to the Vauban system Concept, by finding out the geometric method of the citadel tracing which was discovered after a detailed analysis of the fortress plan and the geometric decomposition of the citadel plan.

As a result of this study had been demonstrated that the fortress is a particular case with earthen rampart, based on Vauban 1st method (method which was taken from Pagan).

The 1st Stage contain the study of the site where the structure is located.

The 2nd Stage: Stage 2 of research contain a process of study of the historical documents (especially old maps) from different periods with are important and concludent for our purpose. It is very important to study as may plans as we can, at least 3 different historical stages, in order to make a good and accurate study. In this case we have study the stages from 1712, 1734 and 1750. It is vital to study many plans because this way we can see the differences from one author to another, also we can make a short history of the evolution process, and we can extract important conclusions and data about the monument past. (fig.3)

Fig.3
Fig 3-research stage II: historical study of the 3 stages from 1712,1734 and 1750.

The 3rd Stage contain a study with a huge importance for us. In the 3rd stage we overlap the old historical maps which we have analysed on stage 2 (stages from 1712,1734 and 1750) over the actual satellite view of the citadel. This process is will be done for all 3 stages in particular. This way we can see the actual differences between the studied plans and the real remains on the site. The overlapping it was mad as accurate as it can be, counting the normal errors of the old plans (fig.4,).

Fig.4. Stage 3. Overlap of the 1712,1735 and 1750 periods over satellite view.
In the 4th Stage we mark with distinctive colours the components of the fortification system, in order for further analysis and conclusions (fig.5). From this study we can see which map is the best fitting with the actual site context, and that stage (in our case 1750) will be used in the next stage to continue the experiment in stage 5.

The 5th Stage consist in choosing the best historic plan that suits our purpose (stage from 1750). This particular stage will be further detailed and will be used for a complete and precise comparison with the actual situation of the relics. (fig.6)

Fig.6- Stage 5. The comparison between the chosen historic stage 1750 and the actual situation of the relics is made.

After this comparison, and after we are sure which historic map is the best fitting with the site, the 3D model, or the 3D restoration can be done (fig.7). On the actual site it is important to be marked all the old buildings still on site and the new insertions made during the years, in our case the Hotel, and the new access road to the hotel, represented in Fig.6-right figure with red (the hotel) and green (the road). Also in the same figure is marked the actual situation of the earthen rampart (white) and the demolished parts (purple).

Fig.7- part of Stage 5 is the 3D restoration model of the historic stage 1750 (this graphic is made by Radu Oltean)

The 6th Stage consist in a deep analysis of the present situation of the relics (the relics). This analysis is made only after the termination of all historical study of the variants.

Fig.8- stage 6, the actual site situation of the relics with the marking on the site-map of all the interior buildings.

This stage actually starts the Restoration Study or even the Restoration Process. This study contains a complete mapping and inspection on the site of the ramparts remains, and the identification on the site of the interior buildings, and their physical shape.

The 7th Stage consist in a complete and very accurate correlation of the actual site with the most recent topographic map done by specialized engineers (fig.9). All the technical details and data should be marked
there, on that plan, including terrain dimensions, including cross-sections on the rampart profile.

Fig.9- stage 7-corelation with the topographic plan.

All this sections will be made through the main components of the citadel: bastions, curtain, gates, ravelin, etc.

3 Problem Solution

Next stage is to find a solution to the problem and finding the right way to rehabilitate and restore the citadel. In order to do that we need to search other examples of this kind.

The 8th Stage consist in a comparation process between this example (Cluj Citadel) and other similar examples from Europe. This is actually a documentary process for the restoration.(fig.10)

Fig.10- study of other similar examples.

In Fig.10 the first figure represent Castle Krzepice, Poland, reconstructed outline of the original fortification which was made according with the 1st system of Adam Freytag, and the 2nd plan represent Castle Dankow reconstructed outline of the original fortification which was made according with the system of Jean Errard de Bar le Duc.

Fig.11- stage 9 reconstruction of the outline

The 9th Stage consist in a deep analysis of the actual stage of the remains, starting from the topographic plan and decomposing the outline in order to find out the geometric trace.

Fig.12-profile analysis Fig.13 restored fortress with earthen rampart in Copenhaga

One of the most important steps in this process is the first step: the analysis of the profile, which shows the particularities of the fortification system (in this case is the 1st Vauban system). A good knowledge of military architecture theory is required in order to make no confusion over the system type. The second step is to find the exterior trace- outline, or the exterior polygon. Usually, at a bastioned fortress, the salients of the bastions represents the main tracing points for that polygon (fig.11).

The 3rd step is to find out the component element of the bastions: flanks, faces,salients value, and any other geometrical relation between elements (fig.11). In that period, the military architects used very strictly rules, with a
perfect military function and rule. Nothing was random when building a fort, that’s why, it is quite simple and easy to follow the method of fortification, if you know the right system of fortification (in this case the 1st system of Vauban).

AN=AM, RB=BS- BASTIO FACE
NQ=MP, RV=TS-BASTION FLANKS
A,E,D,B,C- SALIENTS
ZY=HZ, YZ-J HY, YX=HC, Cc-J BO
ABCDE-The Base Polygon
AO,BO,DO,EO- bastions axis

Finding out all the relations between elements will help us very much when we will start the process of reconstruction for the earthen rampart. In some places the outline is deteriorated or completely destroyed, so knowing the former trace (the original trace) is imperative!

The 10th Stage consist in the actual process of restoration, intervention, conservation and the usage of the monument after the process is finished.

1st is the cognitive analysis (contain historical, morphological, dimensional static features, materials and structural features)

2nd is the stage of planning the hypothesis of restoration and usage.

3rd is the verification of the hypothesis (economical and juridical feasibility according with the conservation principles)

4th is the executive plan

5th is the execution (carry on) of restoration process.

The restoration process will be split on two fronts. The 1st front will follow only the restoration of the inner structures (buildings, gate-house, werehouse), and the 2nd front will follow only the fortification itself, the earthen ramparts including the exterior of the citadel. The remake of the earthen ramparts will be made by using the same type of earth (here will be required a strong geological study) usually taken from the nearby region. All the vegetation will be reorganized, the trees which destroy the ramparts, will be removed. All the existing vegetation will re reorganized.

4 Conclusion:

In order to restore the citadel’s old look, and to bring it to an acceptable shape, it is necesarely to bring life inside it. You can’t bring life inside if is not restored properly. By following the 10 stages I have counted in this paper, good results may be obtain within certain objectives. Knowing the past, helps you knowing to restore the present and preserve it for the future. This casa in particular is the single one in Romania, so it is necesarelly to save the monument asap. A quick,fast and professional intervention is required, following the steps from this paper. Restoring the missing earth with new earth from the same time it is very important, to avoid unexpected conflicts between different types of layers composing the earth. Earthen ramparts will be restored according with the profile provided by the cross-section, as close as possible with the original shape (see fig.12), and where is necessary the vegetation and grass will be replaced and proper sustain,in order to look like new.
5 Acknowledgements
The research works was based on the book wrote by the author, and elements which are part from some other private collections and Museum archives, from Romania. The author would also like to thank to Prof.dr.ing. Stoian Valeriu, and Prof.dr.arh.T. Octavian Gheorghiu for providing historic material from their personal collection.
This work was partially supported by the strategic grant POSDRU 6/1.5/S/13, (2008) of the Ministry of Labour, Family and Social Protection, Romania, co-financed by the European Social Fund – Investing in People.

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