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Meta-Functional Typology of the Forts of Kaunas Fortress

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***Abstract*. This paper presents the meta-functional typology of the forts of Kaunas Fortress as the unique architectural-urban objects that can help to create a more preferred, legible and complex cityscape. Space syntax analysis methodology is applied for the analysis of the forts. Two aspects are investigated. The first one: location of the forts in the axial map of Kaunas is considered while evaluating depth, global integration, local integration and other features of the map. The second one: structure of convex spaces of the all 10 remaining forts is analysed in terms of the depth, "here and there" relations, serial vision, etc. Significant changes or destructions of the original plan of the analysed objects are considered as well. Meta-functional typology of the forts in terms of contemporary architecture is offered. The results of the investigation are significant for the utilisation of the forts within the contemporary urban context.**

***Keywords:* military architecture, utilisation, meta-function, space syntax, Kaunas Fortress.**

Military architecture could be seen as a unique phenomenon that represents the architectural and urban features not met in civil architecture. As the unique objects, former fortifications can help to assure the key features of the preferred urban environment: legibility, complexity, coherence, mysteriousness [1], [2, *223–224*]. Despite the huge architectural-urban potential, the full-fledged integration of the modern fortifications into contemporary cityscape is not an easy task because of the above-mentioned unique architectural features of the objects. The research presented in the article aims to make this task easier by offering a meta-functional typology of the forts of Kaunas Fortress. Kaunas Fortress was constructed in the period 1882–1915 and presents a typical example of the military architecture of the end of the 19th century – beginning of the 20th century. The presented results of the research are of significance related not only to Lithuanian context.

Fig. 1. Global depth map of Kaunas and locations of Forts (black colour indicates five percent of the shallowest axes). Map by Kestutis Zaleckis and Giedre Gudzineviciute

I. Methodology

Cityscape in the article is seen as a complex spatial-social phenomenon. Space syntax methodology [3] has been chosen as the most appropriate one for the identification of the code or architectural genotype of the investigated objects. Investigation has been conducted in two stages: evaluation of the locations of Kaunas forts; identification of the genotype or meta-functional type of the inner structure of the forts. To achieve the above-mentioned objective, the original plans of the forts have been analysed. Changes in the inner structure of the forts made after WW1 have been analysed separately. Names for the meta-functional types of the forts have been selected according to the types of the contemporary architectural objects with similar structures.

II. Original Typology of the Forts

Meta-functional typology of the forts depends on two things: the location of the forts and the inner structure. Locations of the forts of Kaunas Fortress are analysed using the axial map of Kaunas.

Forts in the map of global depth. Using analogy with shallow and deep axes and convex spaces, it is possible to state that the shallow zone of the city tends to be more multi-functional, complex, versatile, integrating, and frequently used. Deep zones tend to be more mono-functional, specialized, episodically used.

According to the Global depth map of Kaunas (Figure 1), three groups of the forts can be identified: a) forts within or in vicinity of 5 percent of the shallowest axes of the city (Fort No. 7) ; b) forts within the zone of 10–25 percent of the shallowest axes (Forts No. 6, 8, 9); c) forts in the deep zone of the city (Forts No. 1, 2, 3, 4, 5; Romainiai, Marvele, Domeikava, Reilroad forts) . The first group is in the highest position in terms of multi-functionality, frequency of use, various public functions, etc. The third group is in the lowest position according to the above-mentioned scale and can be identified as episodically used, mono-functional, specialised, etc.

Forts in the map of the global integration. Axes of global integration show the reachability of the streets at the city level. The most integrating axes are identified as the functional and compositional backbone of urban network, urban frame or "lines of life" of the city in terms of Gordon Cullen [4, *11–119*].

According to the map of global integration of Kaunas (Figure 2), the following forts that are located close to five percent

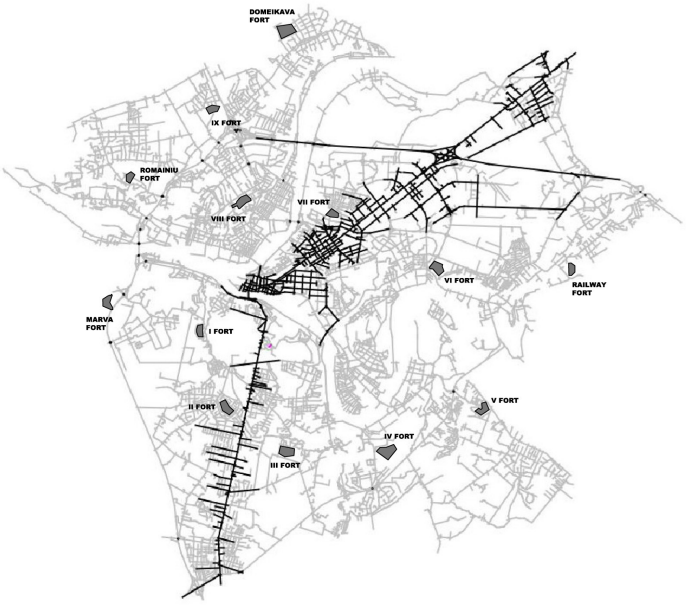

Fig. 2. Global integration map of Kaunas and locations of Forts (black colour indicates five percent of the most integrating axes). Map by Kestutis Zaleckis and Giedre Gudzineviciute

Fig. 3. Local integration map of Kaunas and locations of Forts (black colour indicates five percent of the most integrating axes). Map by Kestutis Zaleckis and Giedre Gudzineviciute

of the most integrating global axes, can be identified as the most significant at the city level: Fort No. 7, No. 9, and No. 2. If the zone of 10 percent of the most integrating axes is considered, then Forts No. 8 and 6 should be added to the group. If 25 percent of the most integrating axes are identified, then Forts No. 3 and 4 should be added. The rest of the forts (No. 5, Romainiai, Marva Domeikava, and Railroad) are of the least significance for the urban frame of Kaunas.

Forts in the map of local integration. Axes of the local integration demonstrate reachability of the streets within a limited distance. It can be measured in meters (e.g., 500m) or in conditional steps. One conditional step means one change of direction while mowing along the street axis. Because of the limited distance, the local integration is used to model pedestrian traffic and placement of the neighbourhood centres in the city.

According to the map of local integration of Kaunas (Figure 3), Forts No. 7, 6, 4, 2, and 8 can perform alone or together with other objects of the centres of neighbourhoods. If 10 percent of the axes with the highest values of local integration are considered, then practically all forts except Marva, Romainiai, and Railroad are included into this zone. The result demonstrates significance of all forts at the local level of the city. Quite a large number of the forts are important both at the city and local level. It reveals the potential of such objects as a specific type of urban central places: besides the specific higher functions they are able to function as the central places of the lower order [5].

Forts in the map of fast choice. Fast choice map (Figure 4) demonstrates the number of choices of each urban axis for journeys from all locations to all locations within the city. The axes of the highest values are the most often chosen ones by traffic flows. The higher traffic flows mean a larger number of spectators and the higher probability of the appearance of the streets in the common mental city image. The same applies to the distinguishing from the context neighbouring objects of the

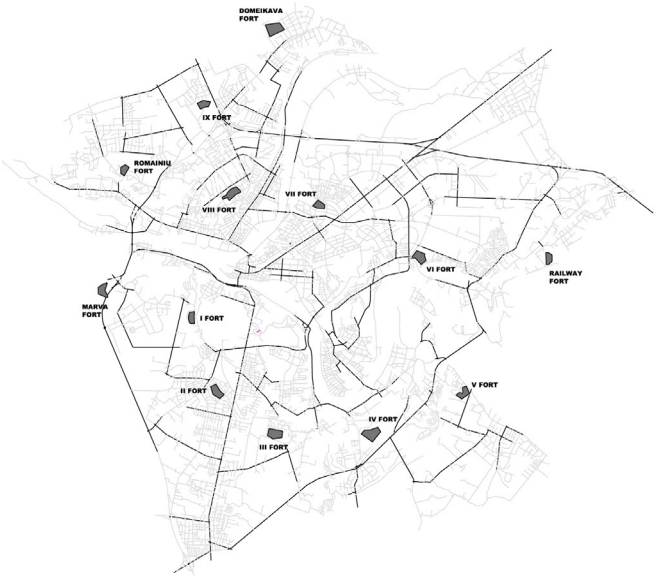

Fig. 4. Fast choice map of Kaunas and locations of Forts (black colour indicates five percent of the most often chosen axes for journeys within the city). Map by Kestutis Zaleckis and Giedre Gudzineviciute

above-mentioned streets. City image in its turn plays a significant role in the assurance of legibility, complexity, coherence of the preferred urban environment. On the other hand, fast choice values represent the traffic attraction, while integration (global and local) is focused more on complex processes of urban life.

According to the map of fast choice of Kaunas (Figure 4), Forts No. 1, 2, 4, 5, 6, 7, 8 and 9 are located close to the most often chosen city routes. The above-mentioned vicinity does not only mean visual perception of the objects by the larger number of people but also higher significance of the forts for conceptual perception of the whole city. In other words, there is quite a high probability that the above-mentioned forts will be present in the

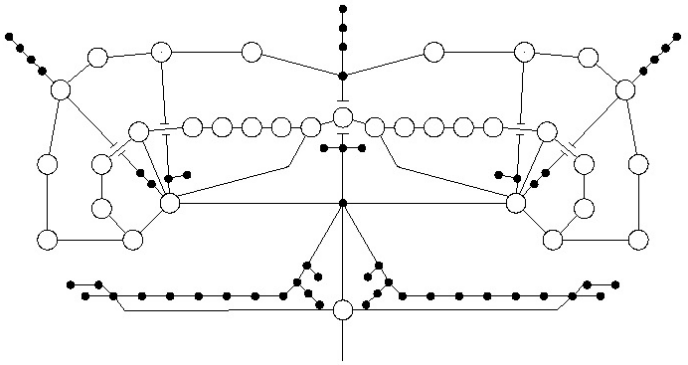

Fig. 5. Structure of the convex spaces of Fort No. 1. Black circles represent the interior convex spaces. Map by Kestutis Zaleckis and Giedre Gudzineviciute

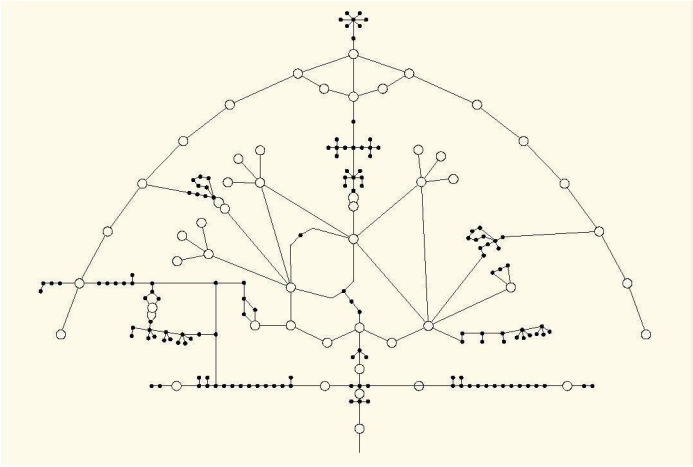

Fig. 6. Structure of the convex spaces of Fort. No 4. Black circles represent the interior convex spaces. Map by Kestutis Zaleckis and Giedre Gudzineviciute

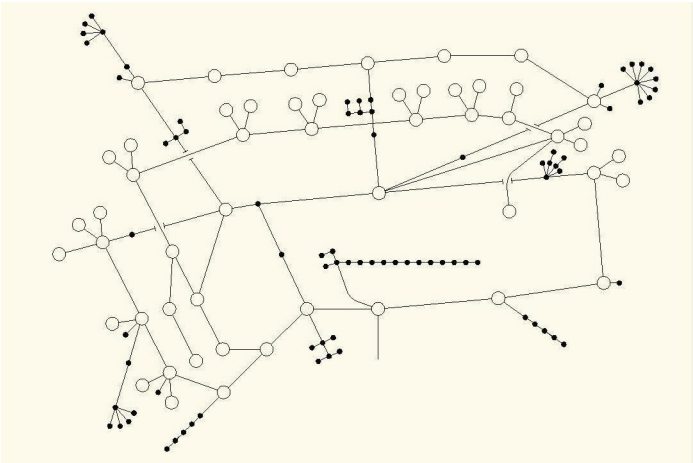

Fig. 7. Structure of the convex spaces of Fort No. 5. Black circles represent the interior convex spaces. Map by Kestutis Zaleckis and Giedre Gudzineviciute

mental city image of Kaunas and will help to assure legibility, complexity and coherence of the whole city at the level of conceptual perception.

While analysing the inner structure of the convex spaces of the original plans of the forts, the following features have been considered: depth, integrity or fragmentation, complexity, characteristics of the structure from the point of view of "serial vision" and perceived "here and there" [4, *17–19*] relations, etc. Plans of the forts are shown as models of convex (visual) spaces. White circle represents exterior convex space. Black circle represents interior convex space. Lines mark the connections between convex spaces.

Forts No. 1, 2, 3 (Figure 5). All tree forts were constructed according to one typical plan. The forts were made of four autonomous zones of different character. The first zone is represented by the courtyard of the barracks. A long façade of the barracks with only three entries to the main postern and the barracks itself creates an architectural code of representative square. Two inner courtyards are separated from each other by the rampart of the central postern. Symmetrical courtyards are surrounded by the hemicircle of the artillery positions at the top of artillery rampart. Artillery positions are asymmetrical to the neighbourhood of fort and separated from each other by traverses. Thus, each of them can be considered a separate convex space. Asymmetry here is understood as a type of visual relations between two spaces. Symmetrical relations mean that observation conditions are identical from both points. Asymmetrical relations mean unequal observation conditions, e.g., environment around the fort can be observed from fire positions within the fort but the possibilities of observation of fire positions from outside are very limited. Artillery positions are open from the side of the courtyard and in both directions represent "known here" and "known there" relation. Architectural code of the two courtyards can be described as an amphitheatre with the hemicircle of observation positions. The infantry rampart with fire positions represents completely different type of space. It is made of enfilade of prolonged spaces closed from both sides. The long axes of the spaces are closed by traverses. Closeness and limited possibility to see what is in the next space can be described as "known here" and "unknown there" relation. Architectural code of the above-mentioned part of the fort can be described as a gallery and labyrinth. Labyrinth-like nature of the zone is strengthened by the entrances to the four posterns of the ammunition depots, central caponier and two semi-caponiers. Maximal depth of the structure from the entrance is 10 conditional steps (crossings of the borders of convex spaces). Important note: forts represent a very deep structure of convex spaces in general in small territory. It should be reminded that the local integration of the axes of the city is calculated for 3 steps only (when the number of the steps is increased, the map of local integrations tends to be more similar to the map of global integration). Despite the fact of big general depth, there are some shallow zones in the forts, e.g., the representative square and the amphitheatric courtyards.

One unique feature of the analysed forts: connections between the autonomous groups of exterior convex spaces are assured only by closed convex spaces of interior. Such an "inside out" code is unique in contemporary urban structures and could be met only in some ancient civilisations, e.g., Pre-Columbian Wari (Spanish: Huari) culture in South America (500-900D) [6]. There are 34 exterior convex spaces and 56 interior convex spaces in one fort (total 90). Both groups of spaces function in an integrated way. In Kaunas downtown quarter there are approximately 40 public or semi-public convex spaces [7], while the area of the quarter and fort is more or less the same. In addition to the large number, a variety of both spaces and their relations in the forts if compared

to the homogenic urban quarter should be noted. It demonstrates the high potential of the inner structure of the forts from the point of view of variety of perception and experiences of serial vision. In conclusion, the original genotype of Forts No. 1, 2 and 3 can be described as Wari type (inside out) heterogenic deep complex of representative square, two amphitheaters and labyrinth-like enfilade of backstage "rooms".

Fort No. 4 (Figure 6). It is one of the largest forts of Kaunas Fortress constructed according to the modified typical plan. Entrance to the fort is organised as a series of labyrinth-type spaces (as in some ancient or medieval fortifications). Not like in Forts No. 1, 2 and 3 there are two crossroads with possibility to choose three directions after the entrances through rear caponier and the entrance in the barracks rampart. It makes the central triple core of the fort functional via closed interior convex spaces or via semi-open exterior spaces. The core is made of three amphitheatric courtyards as in Forts No. 1, 2 and 3. The amphitheatres in Fort No. 4 are much smaller if compared to the above-mentioned forts: here only 4–5 convex spaces surround one side of each "stage" instead of 8 spaces in Fort No. 1. Labyrinth-like nature of the enfilades on the infantry ramparts here is even stronger expressed than in previous forts. The maximal depth of the structure from the entrance is 17 steps. 3 steps are taken only by the entrance to the fort. The structure of the interiors is much more complicated and developed here than in Fort No. 1. In Fort No. 4 they can be seen as autonomous labyrinth-like underground structures. There are 48 exterior and 139 interior convex spaces in the fort. Original genotype of the fort could be described as a complex made of the following: labyrinth-like deep entrance; triple core made of three small shallow amphitheatres; labyrinth-like enfilade of backstage spaces accessible only via closed and deep (from 4 to 11 steps) interior spaces, 6 autonomous islands of deep underground labyrinths.

Fort No. 5 (Figure 7). It is the fort of asymmetric plan with artillery battery located outside the fort. Entrance to the fort is made by the representative square in front of the barracks. One big amphitheatric courtyard, surrounded by 17 smaller convex spaces, is located behind the barracks. Entrance to the courtyard was assured by shallow postern (2 steps) or one exterior convex space on the left side of the barracks. Two alternative deep ways through the second small courtyard and part of the infantry rampart were available as well. The second small courtyard represents the sequence of two small amphitheatric spaces and can be described as rehearsal halls. Infantry rampart is represented by two autonomous simple segments. Their labyrinth-like structure is reinforced by entrance to the central caponier, semi-caponier and three ammunition depots. Maximal depth of the fort from its entrance is 9 steps. There are 54 exterior and 79 interior convex spaces in the fort. Original genotype of the fort can be described as a group of the following: representative square; big amphitheatre with few small rehearsal halls; two autonomous relatively shallow labyrinth-like backstage enfilades. The expression of "inside out" code here is limited to the deepest art of the fort (as in Fort No. 4).

Fort N.o 6 (Figure 8). It has a symmetrical plan with the barracks pushed to the centre of the fort. Position of the barracks and walkable rampart at the top of them create circular amphitheatric spaces around two courtyards. In contrast to the other courtyards of the forts these two can be named arenas. Entrance to the fort combines the labyrinth of the rear caponier with the representative square in front of the barracks. Infantry rampart creates the same type of labyrinth-like enfilade along the perimeter of the object as in the other forts. Another unique feature of Fort No. 6: interior convex spaces are not necessary to assure connections between the exterior convex spaces; thus, the fort can function as a traditional urban system

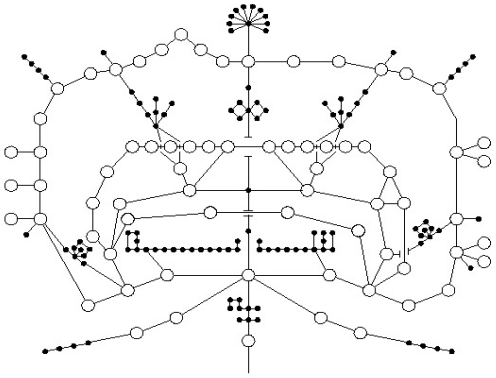

Fig. 8. Structure of the convex spaces of Fort No. 6. Black circles represent the interior convex spaces. Map by Kestutis Zaleckis and Giedre Gudzineviciute

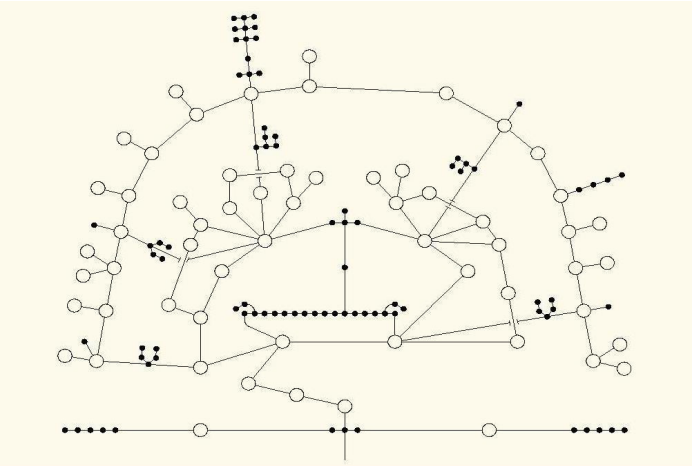

Fig. 9. Structure of the convex spaces of Fort No. 7. Black circles represent the interior convex spaces. Map by Kestutis Zaleckis and Giedre Gudzineviciute

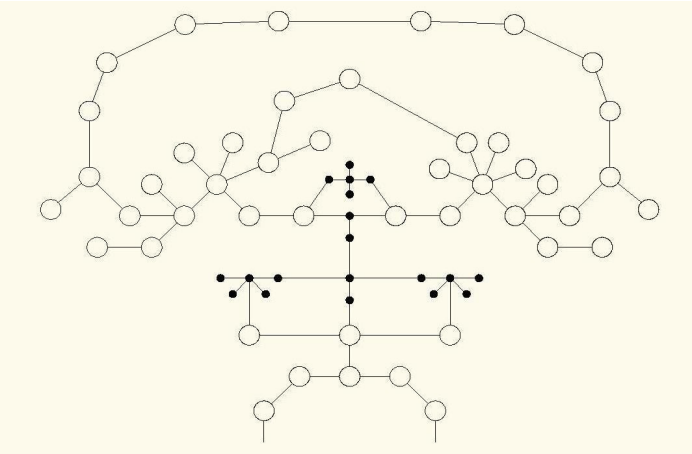

Fig. 10. Structure of the convex spaces of Fort No. 8. Black circles represent the interior convex spaces. Map by Kestutis Zaleckis and Giedre Gudzineviciute

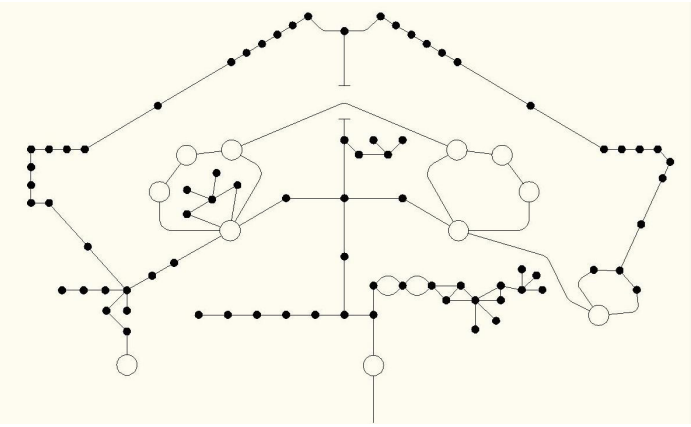

Fig. 11. Structure of the convex spaces of Fort No. 9 (ground floor). Black circles represent the interior convex spaces. Map by Kestutis Zaleckis and Giedre Gudzineviciute

of exterior volumes with added buildings. Due to the big size (average size is 7–8 convex spaces) and the above-mentioned integrity of exterior spaces, islands of underground casemates can function in a truly autonomous way in the fort. The maximal depth of the fort is 16 steps from the entrance space. There are 71 exterior and 112 interior convex spaces. Original genotype of the fort can be described as the labyrinth-like complex of the exterior spaces with two arenas in the centre and numerous truly autonomous underground islands.

Fort No. 7 (Figure 9). It has a small asymmetric plan. The double entrance through the labyrinth of rear caponier with the entrance ramp and representative square in front of barracks is present in the fort. Behind the barracks the two amphitheatres can be found as in the other forts. The unique feature of these spaces in this fort is the following: the scene of the amphitheatre is made of few convex spaces instead of one. Such a structure allows for organisation of more sophisticated events and shows. Entrances to the amphitheatres are assured by the central postern and bypasses of the barracks. Infantry rampart creates the labyrinth-like enfilade characteristic of Kaunas Fortress. Its labyrinth features are strengthened by spaces for the counter assault artillery on the left and right flanks of the fort. The "inside out" access code is functioning only for the infantry rampart. The maximal depth of the structure is 17 steps. There are 61 exterior and 3 interior convex spaces in the fort. Original code of the fort can be identified as follows: the complex of representative square and two amphitheatres with multi-spatial stages; autonomous labyrinth-like enfilade.

Fort No. 8 (Figure 10). It is the first concrete fort in Kaunas Fortress. Entrance to the fort was made practically directly via barracks hidden in the rampart. From the barracks the central poster leads to ammunition magazine and two amphitheatric courtyards. Ramps from the courtyards to the top of the rampart over the barracks give the features of arena to the spaces. Labyrinth-like enfilade of the infantry rampart is connected to the two arenas by the exterior convex spaces. Maximal depth of the structure is 14 steps. There are 46 exterior and 19 interior convex spaces in the fort. Original genotype of the fort could be described as the following dual structure: the barracks with the postern and ammunition magazine; two arenas and enfilade of the labyrinth.

Fort No. 9 (Figure 11). It is the newest fort of Kaunas Fortress built in the period 1903–1913. All communications of the fort were organized in underground casemates. At the entrance of the fort, a representative square was formed. The rest of the fort represents the homogenic structure of the underground labyrinth-like enfilades with three isolated exterior islands (courtyards) in the centre. The plan of the first floor contains the barrack itself with the exit to the rampart at the top. From the roof of the barracks there is a direct connection through the rampart of the central postern to the fire positions in the front of the fort. Fire positions and the rampart of the barracks surround the courtyards and form two small arena-type spaces. Important note: the arenas cannot be used autonomously without the underground labyrinth. The characteristic of the fort is the presence of two vertical levels of organisation. In the other forts all parts are more or less integrated in one plane. There are 12 exterior and 78 interior convex spaces on the ground level of the fort. There are approximately 1 exterior and 10 interior convex spaces on the first level. The original genotype of the fort can be described as the homogenic labyrinth made from dominant underground passages and the depending island of exterior spaces in the centre.

The original plans of Marva, Romainiai, Domeikava and Railroad Forts are not analysed in this article because of the unrecognisably transformed original structure or only partially implemented initial plans.

In general, tree typological groups of the forts can be identified according to the inner structure of the objects.

III. Alterations of the Meta-Functional Types of the Forts

During exploitation of the forts after WW1, many changes were made there. Even if the above-mentioned changes do not look very significant from the architectural point of view, the conducted analysis has revealed the significant alterations of the genotype of the objects.

Fort No. 1. In the fort the infantry rampart was repealed during the modernisation before WW1. As a result, the deep labyrinth-like backstage enfilade and 12 exterior convex spaces are lost. During the battles some casemates were destroyed and the number of interior convex spaces decreased as well. In the Soviet period, windows of the barracks were changed into car gates, thus transforming the representative square into the market square.

Fort No. 2. The additional entrance is made from the representative square to the amphitheatre.

Fort No. 3. Two additional entrances are made through both infantry and artillery ramparts to the both amphitheatres.

Fort No. 4. Some casemates and part of the ramparts were destroyed on the right flank of the fort. The number of convex spaces was decreased a little because of the destruction.

Fort No. 5. On the left flank the two small amphitheatres together with part of the casemates were destroyed and the space structure became simpler there (~ 10 convex spaces were lost). On the right flank the autonomous part of the infantry rampart and fire position is destroyed and unreadable. Because of the Soviet reconstructions of the barracks, the representative square was changed to the market square. Additional entrance through the ditch and infantry rampart was made to the courtyard through the postern of ammunition depot. Artillery rampart was left intact.

Fort No. 6. Rampart of the barracks is not walkable at the moment and arenas are transformed into amphitheatres. Additional entrance to the representative square directly through the rampart makes the unique feature of the dominant exterior spaces even more obvious.

Fort No. 7. The entrance is made directly to the representative square. It reduces the maximal depth of the structure by 4 steps.

Fort No. 8. The additional entrance is made to the right courtyards of the fort through the rampart. It makes the dual structure of the fort even more balanced. Now each of two parts has its own entrance and can function autonomously. Slope of the infantry rampart is used for the gardens of inhabitants, but it does not change the structure of the fire positions.

Fort No. 9. The fort was not changed in essence. Before WW2 it functioned as a prison. During WW2 it was used as a concentration camp. Functional modifications made because of the above-mentioned functions were the following: construction of the courtyard surrounded by the wall in front of the barracks; construction of the control point at the entrance to the newly built courtyard. These changes influenced just the transformation of the representative square.

In general, it can be concluded that in many cases some minor features or parts of the inner structure of the forts were lost, but in general the main unique characteristics of the code are still present. In some cases (e.g., transformation of the representative square into the market square; separate entrances to the autonomous zones, etc.), the changes just modified the possible way of usage of the unique spaces.

Conclusions

Meta-functional types of the forts of Kaunas Fortress are identified according to the location and inner structure of the objects. Three groups of the types have been identified: forts of the "inside out" code; forts as complexes of spaces with buildings; underground labyrinth. There are some forts that do combine features of two types.

The common unique features of the fort genotype: big depth, tree type (in opposition to the dominant network type structure of the cities), labyrinth structure, presence of amphitheatric spaces, variety of the spaces and spatial complexity.

Some changes or destructions in the forts made significant alterations of the code of the object but it has preserved its unique features. Locations of the forts give additional dimension to the fort meta-typology. The following groups of the forts can be identified: central places of the highest rank with the high importance for the city and local neighbourhoods; local centres, specialised objects of the episodic usage; objects of the city image importance.

The presented two layers of typology (location and inner structure) can be used in combination as the background for architectural interpretation and utilisation scenarios of the forts.

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