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ROOFS FOR INTEGRATION OF ARCHAEOLOGICAL SITES INTO METROPOLITAN AREA

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Abstract

Archaeological sites within urban areas are frequent and it is reasonable to expect that further urbanization towards metropolitan area will increase number of discovered and subsequently presented heritage sites, which keeps the problem actual. Increase of number of metropolitan areas worldwide opens discourse about role of immovable heritage in their development and defining of metropolitan public spaces in response to their rediscovered built heritage.
Presentation of archaeological sites in situ often requires construction of roofs and shelters. Considering that sustainable metropolitan development further enhances demands for land efficiency, built heritage is further exposed to risk and pressure. Having in mind that heritage sites typically occupy locations with greatest advantages, spatial conflicts regarding land use is always increasing. We examined one of possible resolutions: covering archaeological sites in such way that they become part of public space, within urban areas and between them, in area urbanized for need of metropolis, from the point of sustainability of the concept and desired characteristics of optimal technical solutions in light of demands regarding design of public space and archaeological presentations.
We concluded that specific layering of public space - multiplication of available public area and integration of heritage finds in its design, enrich its values (which we conveniently summed in Vitruvian terms: *firmitas*, *utilitas* and *venustas)*, and, at the same time, increase the capacity for sustainable development in contemporary terms, successfully resolving spatial conflicts between past and future, *de facto* between archaeological sites and metropolitan area.

Key words: Metropolitan area, archaeological sites, public space, structure, roof

1 Introduction

Archaeological sites within urban areas are frequent and it is reasonable to expect that their further urbanization towards metropolitan area will increase number of discovered and subsequently presented heritage sites, which keeps the problem actual. Increase of number of

metropolitan areas worldwide opens discourse about role of immovable heritage in their development and defining of metropolitan public spaces in response to their rediscovered built heritage.
Presentation of archaeological sites in situ often requires construction of roofs and shelters. Considering that sustainable urban development sets permanent enhancement of demands for land efficiency, built heritage is further exposed to risks and pressure, particularly having in mind that heritage sites typically occupy locations with greatest natural advantages. Therefore, we examined one of possible resolutions of those always-increasing spatial conflicts regarding land use: covering archaeological sites in such way that they become part of public space. We considered sustainability of the concept and desired characteristics of optimal technical solutions (e.g. spans in correlation with shape of roof) in light of demands regarding design of public space and archaeological presentations.
Within urban areas, archaeological researches frequently reveal a many buried historical layers under contemporary urban tissue. That happens because contemporary and past settlements often develop at the same location in response to unchanged natural advantages. The other group of problems appears outside of urban areas: many archaeological sites are discovered during preparatory works of highways and other infrastructure. While those two groups of problems must be treated differently in urban planning (inside and outside of urban area), in new metropolitan planning they could be addressed simultaneously by the same general approach. Possible resolution for the problem of presenting archaeological sites *in situ* (when it is justified) lies in constructing roofs or shelters which, at the same time, protect archaeological finds and are used as new ground level of public space.
We started with the hypothesis that specific layering of public space enriches land values, increases the capacity for sustainable development in contemporary terms and successfully resolves spatial conflicts between past and future, *i.e.*, more specifically: between archaeological sites and metropolitan area. We examined if this approach may adequately resolve the described problem trough multiplication of available public area and integration of heritage finds in its design.

2 A look into the past

There is a long tradition of setting shelters and roofs above the archaeological finds, when they are presented *in situ* and when they are not. Since the beginning of 20th century built heritage was exhibited in museums especially built for that purpose (Fig. 1 shows the roof construction above the Pergamon Altar in Berlin), while in other cases roofs and shelters were built above archeological finds *in situ*, in both cases as protection from precipitation, releasing weathering, aging and similar. In both groups of cases the purpose is essentially the same.

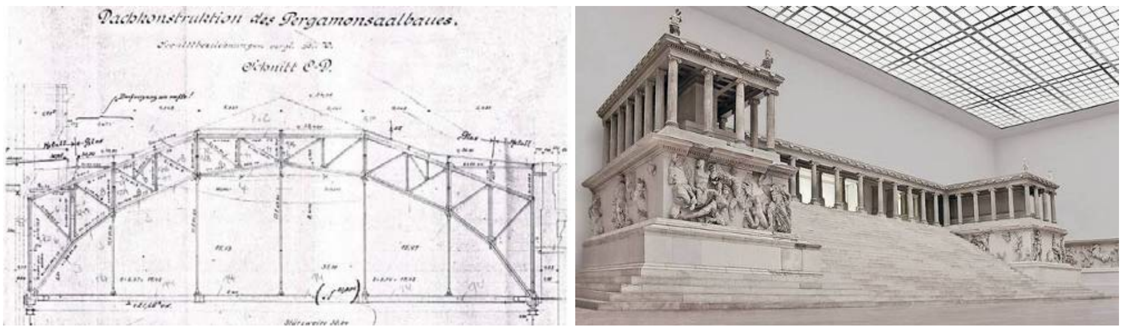

Fig. 1 Roof above the Pergamon Altar, Berlin, Germany [1]; the museum has been erected between 1910 and 1930 and it has ca. 30 m wide span steel truss covered by glass with a false ceiling, which lets in natural light.

Many case studies of protective buildings for archaeological sites presented *in situ* have been published by now, therefore, the following chapter gives only an overview of possible structural designs of roofs.

3 Structural design possibilities

In general, there is great variety of possible constructions, as shown in Fig. 2. The main structural members are subjected to either compression or bending or tension.

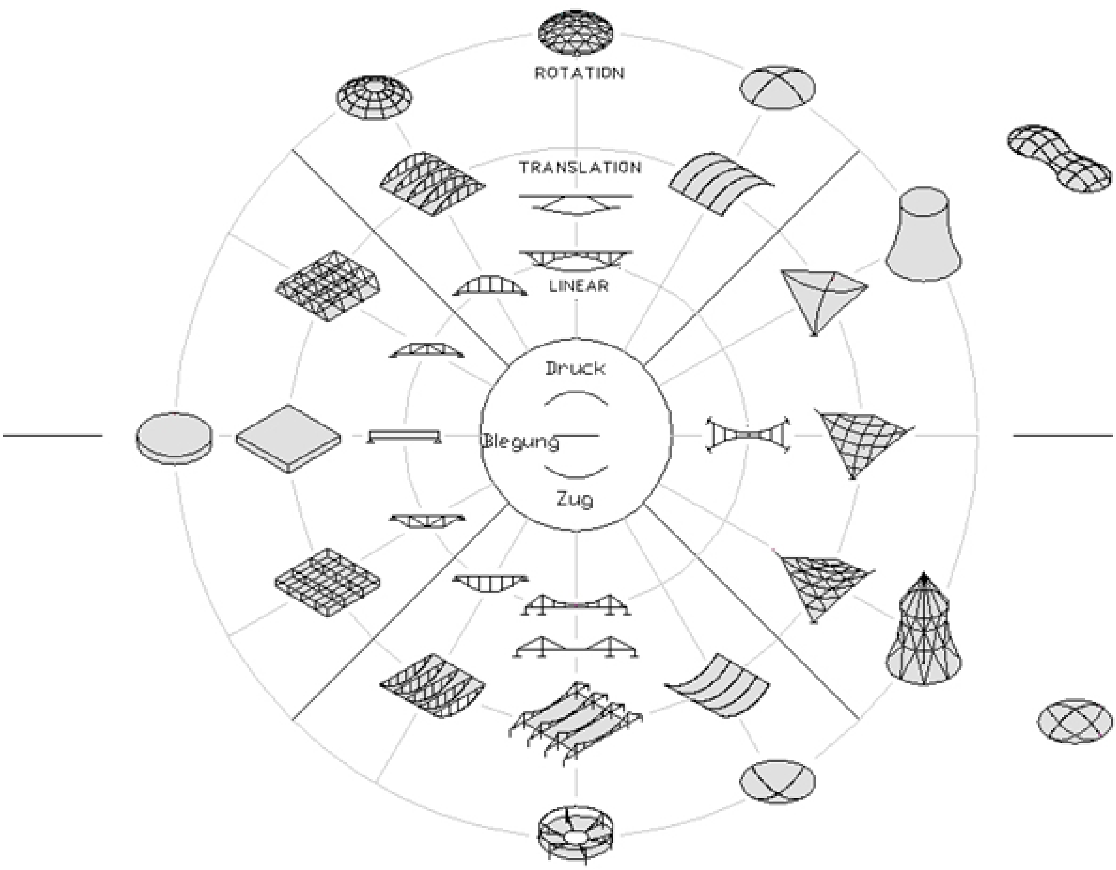

Fig. 2 Types of structures [2]

Possible scope of solutions narrows when required spans are taken in the account. Spans can be frequently used as eliminating criteria in case of single heritage buildings (base on previous knowledge about historic materials and technics), but rarely in case of urban archaeological finds.

3.1 Girders

The Pallas of the castle (from around 1250) in Vlotho has been reconstructed before WW II. A contemporary designed shelter from steel [3] was added, along with works on reconstruction of castle after 2000, giving an idea of how original building looked like (Fig. 3). The optimum span for hot-rolled girders is up to 9m.

Fig. 3 Medieval Pallas in Vlotho, North Rhine Westphalia, Germany [3]

Fig. 4 Acropolis, Athens, Greece [4]

3.2 Underslung girders

Underslung girders consist of hot-rolled profiles and round steel and have the optimal field of application between 9 m and 18 m. The advantage of those girders lies in smaller internal forces and deflections under uniform loading than for simple girders. This results in a slimmer steel construction of the roof, which combines well with glass (Fig. 4). The church St. Pauli (Fig 5) in Dresden has been built in 8 months in 1889. It was bombed by the US Air Force in March 1945 [5]. In 2011/12 underslung girders in combination with glass were applied. Now the heritage is used as church and a theatre in summer.

3.3 Frames

Finds from the Byzantine time, situated near the Ohrid Lake, were sheltered with traditional members (Fig.6). This frame consists of hot-rolled hollow sections and has an optimum span range up to 15m.

Fig. 5 Church St. Pauli, Dresden, Germany [5]

Fig. 6 Shelter in Plaosnik, near Lake Ohrid, FYROM [6]

Fig. 7 Heritage agriculture building and its steel frames in Lucklum, Lower Saxony, Germany [7]

In the following example, the masonry walls have been too weak for construction of a new roof on it, in an agriculture building in a manor from the 17th c (Fig.7). Therefore, the steel frame is set inside to preserve the outer historical view. In case of welded sections, spans of as many as 80 m are acceptable.

3.4 Trusses

Trusses (with a single upper and lower chord) have a span optimum between 15 m and 30 m. They are the convenient for combining with glass or translucent membrane. Figure 8 shows the roof near the center Athens which covers a Roman Bath.

Fig. 8 Truss roof, near the Syntagma square in Athens, Greece [8]

Another example, houses in Ephesus [9] are shown in Fig 9. In this archaeological site of ca. 4000m^2, there is large insula with seven residential units from 1st century BC, designed according to the terrain on terraces. The buildings were damaged by big earthquake series in 262 AC. Nowadays, they are protected by roof that is made of stainless steel and textile translucent membrane.

Fig. 9 Ephesus, Turkey [9]

The Hamar Cathedral (Fig. 10), which is located 100km north of Oslo in Norway, was built until 1152 and destroyed by Swedish army in 1567. What was left of it (mostly remains of arches) is now protected by a truss construction.

Fig.10 Hamar, Norway [10]

3.5 Arches

Generally, arches allow widest spans. Fig. 11 shows a two-hinged steel truss arch above the middle stone age and Neolithic site in Lepenski vir, which is situated outside of urban are [11]. The span is approximately 50m. Fig.12 demonstrates a wooden two-hinged arch (span 72,5m) in Nis [12] above a villa (98 x 63 m) that was built at the time of Emperor Constantine the Great, who was born in the city. It is situated in roughly 250ha protected land for mixed communal (water supply) and cultural purpose, but nowadays it is fully surrounded by urban tissue.

Fig. 11 Lepenski Vir, Serbia [11]

Fig. 12 Mediana, Nis, Serbia – Late Roman villa [12]

3.6 Shells

The Dresden Castle, a Renaissance building in the center of the city, demonstrates use of shells (Fig. 13). The castle was residence of Saxon electors and kings. It was bombed by the allies on February 13, 1945 and later rebuilt. In 2009 a steel grid shell with foil cushions were added. The structural model shows a framework dome, consisting of a grid shell and a surrounding edge truss girders at the dome base [14].

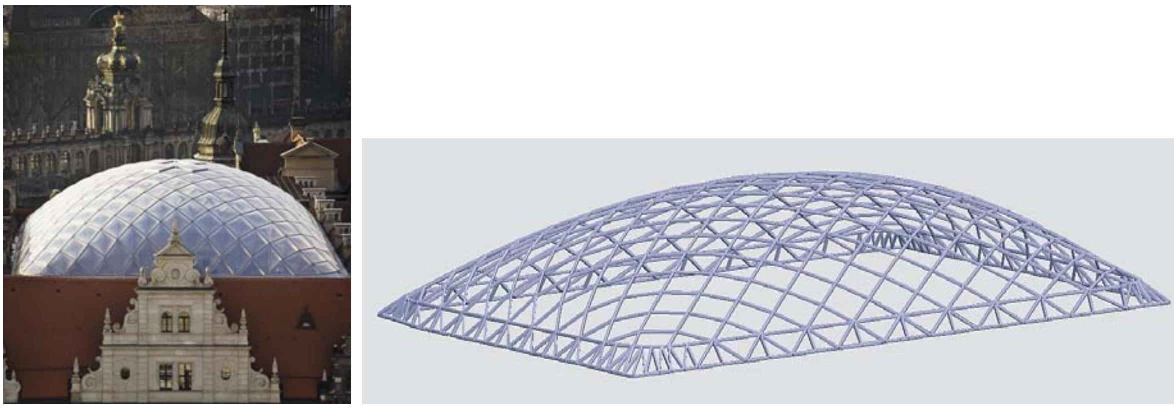

Fig. 13 Dresden Castle, roof above small yard [13,14]

Pig iron first flowed from the blast furnace of the St. Antony ironworks in 1758. Today, this first ironworks in the Ruhr region is part of an industrial archaeological park. The 900m^2 shell roof has 323 similar panels overlapping each other like shingles. Due to their double-curved shape and rigidity, the shell is self-supporting and does not need any welding (Fig.14).

Fig. 14 Oberhausen, Germany [15]

Fig. 15 Tent above archaeological site in Rhodes, Greece [16]

3.7 Tent structures

When the climatic conditions allow it, a simple awning may be satisfactory (Fig. 15). A more demanding example is the Kufstein Fortress (Fig. 16). For high quality events, weathering protection is important. It happened few times that concerts literally fell into water in bad weather, while other events never happened because of financial risks. Thus, the idea arose to make the largest possible part of the fortress weatherproof by temporary retractable protective roof.
Strict requirements of the monument protection had to be considered, which did not allow anchoring in the historical structure. The appearance of the fortress had not to be affected by the new construction. In order to meet these conditions, so the planners developed filigree, centric cable structure, from which a membrane can be stretched. This convertible canopy allows covering 2000m2 over the entire fortress yard and part of the casemates in 4 minutes. In good weather the membrane is situated in the center.

Fig. 16 Fortress Kufstein, Austria [17]

3.8 Some details

Examples for the connection of profiles with glass, with membrane or with foil cushions are given in Fig.17 [18,19,20]. The double membrane or cushion is needed to heat.

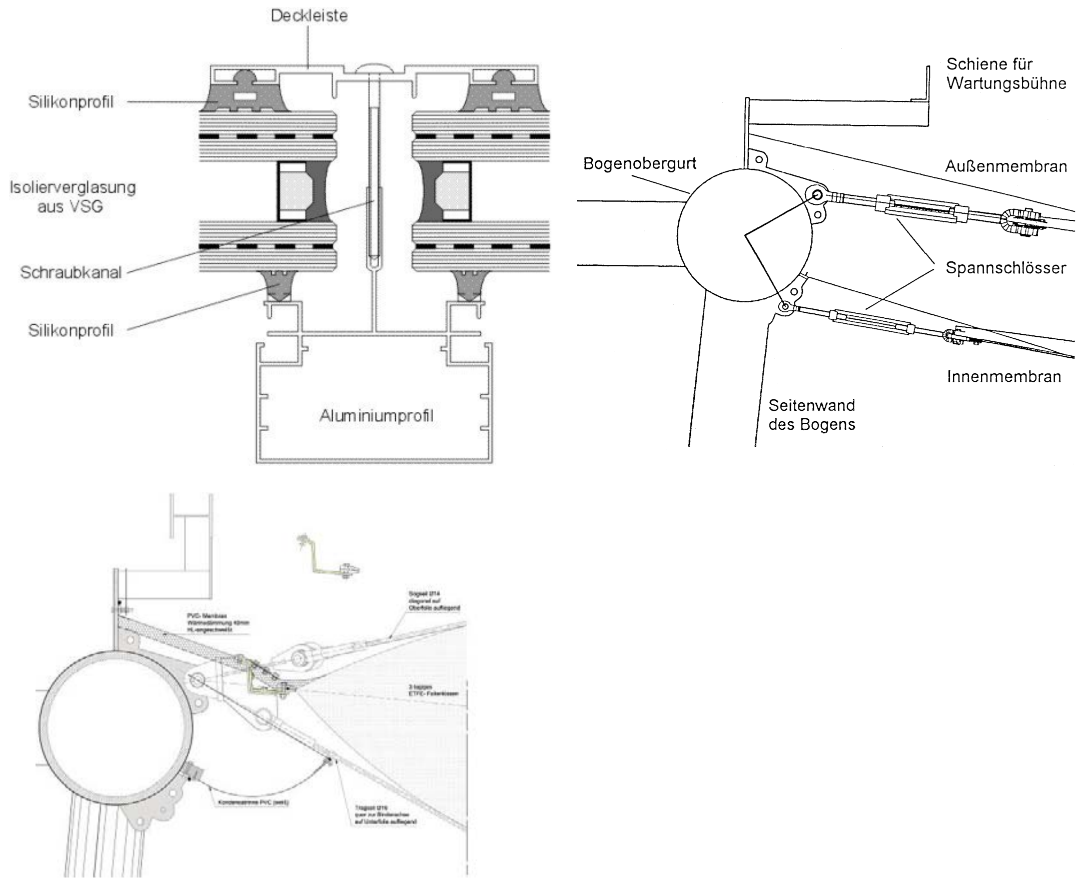

Fig. 17 Details

4 Walkable roofs and why their design is different

Under walkable roof, here we consider roofs which can serve as new ground level of public urban area. Their supports can be partly or entirely underground. Different shapes of roof are possible; however, as a part of public space, such roofs should meet requirements regarding barrier-free design and alike, i.e. inclination of such surfaces is not allowed to be more than 5-7% (according to regulations in most of EU countries), they typically must carry fences, surface must not be slippery and must be long-lasting, colors must be contrasting for people with impaired vision, steps must be appropriate size etc.

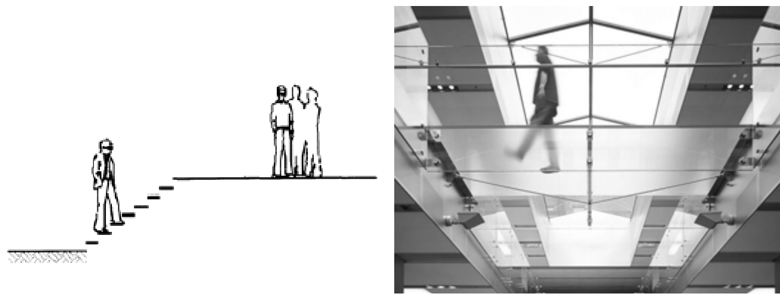

Fig. 18 Walkable glass (including stairs) [21]

Fig. 19 Center of Sofia [22]

Generally, girders, beam-to-column solutions, frames or flat grid shells in combination with laminated glass are possible for walkable roofs. The traffic load (people) is 5kN/m2. Therefore the use of laminated safety glass in at least three layers is required. Glass dimensions of 2000x2000mm are possible with thickness up to 70mm. Bent glass is also feasible. The substructure dictates the span for walkable roofs, which is in every case shorter than the span for "normal" roofs. In some cases roofs are only partly visible, and in others they are used only for providing natural light, similar like in museum buildings combined with flat pedestrian surfaces (Fig.19).

6 Discussion and concluding remarks – potential significance of walkable roofs for land-use efficiency

Variety of possible solutions opens question regarding evaluation. In general, criteria for evaluation can be conveniently summed up in Vitruvian terms, as *firmitas*, *utilitas* and *venustas*. The list of technical requirements which significantly narrows scope of possibilities, include: load/weather conditions, span, safety, serviceability and durability, which we can all put under *firmitas*. However, there are many other aspects which should be taken into account, as aesthetical value of intervention, functionality of provided public space – the roof surface as well as the space underneath *etc*. Utilitas is predominantly provided by multiplying of available public space (of which one has heritage value) which has many social and economic benefits. One of most evident benefits is providing additional public space at the same time while improving accessibility to heritage. Benefits of heritage accessibility, as positive effect on identity of space, educational contribution, strengthening relations within community *etc*. have been already extensively analyzed in scientific literature and therefore there is no need to discuss them further here as well. Speaking of *venustas*, protective buildings evidently change genuine landscape of archaeological sites and overall impression. The problem of evaluation was subject of many researches, and since middle of 20th century, methods for aesthetical evaluation significantly improved. Here, only guidelines for analyses of this aspect will be mentioned. Returning to the route of aesthetical theory of heritage, i.e. interpreting Brandi`s restoration theory [23] in this context, such interventions may be considered aesthetically successful if they are work of art, by themselves, not depending on archaeological finds beneath (Fig. 20), while oversimplified museum design, non-authentic architecture, architecture unrelated to the time of construction and other conceptual mistakes, among numerous possible, lead to aesthetical failures (Fig. 21). In Brandi`s terms, it is not possible to create work of art intentionally, therefore if such structures aesthetically fail, they could/should be replaced by a successful one. It is commonly known that museum design has been typically an opportunity for setting new standards in contemporary architectural design, and archaeological museums are not (necessarily) exceptions. Fortunately, due to advanced virtual presentation technics, attempts to achieve artistic values can nowadays be evaluated already at design stage.

Fig. 19 [24]

Fig. 20 Mediana Museum, built 1934-1939, Nis, Serbia [25]

New technical and technological solutions materials enable authentic, creative presentation of heritage which makes heritage more accessible. Presentation of Stadium in the center of Plovdiv, Bulgaria was very demanding and expensive (Fig. 21) [26]. However, if that presentation included full presentation of Stadium, visible from above, with additional space for different public contents including commercial, and at the same time making heritage itself more visible and integrated in daily life, the intervention will be much closer to standards of sustainability than it is now [26]. Furthermore, heritage presentation can be an occasion for best of contemporary architecture. In that manner, heritage keeps a role which we are aware of, since long time, and that is – of a catalyst of socio-economic development [27].

Fig. 21 Plovdiv Presentation of Stadium under city center

Fig. 22 Cracow Historical Museum under the Main Market [28]

True significance of roofs above archaeological sites used as new public space can be properly understood if considered trough paradigm of metropolitan discipline. The significance of walkable roofs as practical solution is seen in light of contemporary demographic trends marked by raise of metropolises. At the beginning of 20th century, there were only 3 metropolitan areas, and at the beginning of 21st century there are around 300 of them [29]. Once far in the countryside, untouched, nowadays it is on the way to be fully urbanized, and heritage on the route of urbanization is under treat. In conclusion, our world is changing, and heritage experts should keep pace.

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