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THE DESIGN METHODS OF THE CHEŁMNO LAND'S CONVENTUAL CASTLES. A CONTRIBUTION TO THE STUDY OF THE USE OF QUADRANGULATION IN THE TEUTONIC CASTLE BUILDING

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Introduction

Massive and regular bodies of conventual Teutonic castles have been the subject of fascination and research works of scientific world for the last two hundred years. Archaeologists, historians, historians of architecture and art have been considering genesis of their form, architectonic features, as well as building techniques and materials. Admiring the results of building workshops constructing castles, like Radzyń Chełmiński or Papowo Biskupie it is hard to resist from expressing a question, concerning the way of their building, which does not refer only to strictly constructive matters, but a mode of their designing, as well.

Taking into account history of the theory of architecture, the Middle Ages seem to create void between the Antiquity and the Renaissance. Despite developed literature on many branches including building, no theoretical architectonic rules were formed in that period[1]. Ancient knowledge was not completely abandoned, though. Copies of texts belonging to architecture theorists, such as Vitruvius, delivered only general rules and some practical building remarks. Lack of defined rules, shaped into treatises, is explained by Maria Łodyńska-Kosińska as a result of some factors, among the others, the fact that in the preliminary period of mediaeval architecture development the division took place, distinguishing persons occupied by theory of architecture – investors, clergy, who created only sketched designs and craftsmen, coming from lower social classes, deprived of theoretical abilities. The clergy, not disposing practical knowledge and who were only able to form general design, could not create complete rules of new architecture. The craftsmen, who were illiterate, did not possess theoretical knowledge. Even when their groups emancipated more and more, together with town development and appearing self-sufficient specialists, working at orders and not dependent on one site, their eminent representatives were not able to form in writing such theories, because they were not scholars and were unable to use theoretical language[2]. Mediaeval builders, however, spread and so-

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[1] M. Łodyńska-Kosińska, *O niektórych zagadnieniach teorii architektury w średniowieczu,* „Kwartalnik Architektury i Urbanistyki", IV/1959, p. 3.

[2] Ibid., pp. 15-18.

lidified the necessary skills within their own group. To obtain some knowledge, they used patterns including drawings and comments, which served as a kind of a text book. The sketchbook of Villard de Honnecourt (after 1230) is the most famous work of that kinds. Much information is also delivered by texts of a few late gothic architects, like: Mathias Roritzer *Büchlein von der Fialengerechtgkeit,* printed in Regensburg in 1486[3] and Hans Schmuttermayer *Fialenbüchlein* from 1484[4].

Situation looked similar in the territories of the Teutonic Prussia. Builders inhabited towns, and as it results from studies of Marian Arszyński[5], they were employed on contracts for particular investment and they could have had great impact on the appearance of the designed constructions[6]. In the area of Teutonic Prussia at the end of 13th c, a compact concentration of conventual castles with regular, close to a square plan were built. These fortresses were equipped with four dwelling wings, internal yard with arcades around and sometimes towers of bergfried type[7]. First square, four-winged structures were erected in The Chełmno Land[8]. The appearance of this homogenous group of constructions have been capturing the imagination and stimulating scholars research. This selected form could not have been accidental in castle architectonic landscape of Prussia, what is confirmed by homogeneity and domination of this fortress group. The researchers who assume elaboration and acceptance of a ready-made model agreed with its various origin, e.g. according to Marian Kutzner it was first worked out in central circles – by home masters in the 60s of 13th c[9]. Szczęsny Skibiński also thinks, that this form was selected in Prussia[10]. Kazimierz Pospieszny is of a differ-

ent opinion and he suggests, that the model of conventual castle was made in Sicily or in Marburg[11]. Unfortunately, none of treatises or source material suggesting other texts' existence, which would codify appearance and the mode of regular conventual fortresses erecting have been preserved. Therefore, the question concerning clear and defined guidelines referring to requirements as to a form and planning these construction must remain unanswered.

During analyses of epoch source material, Marian Arszyński happened to find records, which in his opinion, confirm design drawings existence. Two terms appear there, which define these drawings: situating – *gelegenheit,* and presenting general building shape – *gestalt*[12]. Measurements and detailed construction plan in the area was performed during site inspection and preparing the building site. Chains may have been used to these activities, the same, which were employed while measuring farm lands.[13]. Knowledge of geometry, applied in designing churches as early as in Romanesque architectonic period, must have been of great importance in this case. Geometrical methods, used by architects, based on drawing triangles and squares, came from antiquity – from Vitruvius' work. Common method application, used by the theorist in designing theatres, made it possible to use it also as abstraction and implement it in various kinds of building structures. The other favorable fact was that these geometrical treatments requires only the simplest manipulations within the science branch[14]. It must be remarked, however, that the designing can not be perceived in a modern meaning, since first of all, general proportions, sizes of building elements were estimated in this way.

[3] J. Habbel, *Das Dombaumeisters und Buchdruckers M. Roritzers Büchlein von d. Fialengerechtigkeit… dem Urdruck nachgebildet,* Regensburg 1922.

[4] Reprint in *Anzeiger für Kunde der deutschen Vorzeit,* Nürnberg 1881.

[5] M. Arszyński, *Technika i organizacja budownictwa ceglanego w Prusach w końcu XIV i pierwszej połowie XV w.,* „Studia z dziejów rzemiosła i przemysłu", 9/1970, pp. 85-86.

[6] This opinion was supported by Christofer Hermann (Ch. Hermann, *Mittelalterliche Architektur im Preussenland. Untersuchungen zur Frage der Kunstlandschaft und –Geographie*, Petersberg-Olsztyn 2007, pp. 120-121, 141-142.

[7] M. Arszyński, *Die Deutschordensburg als Wehrbau und ihre Rolle in Wehrsystem des Ordenstates Preussen,* [in:] "Ordines Militares. Colliquia Torunensia Historica" no 6: *Das Kriegswesen der Ritterorden im Mittelalter*, ed. Z. H. Nowak, Toruń 1991, pp. 105-106; *Leksykon zamków w Polsce,* ed. L. Kajzer, S. Kołodziejski, J. Salma, Warszawa 2001, pp. 38-40.

[8] T. Torbus, *Die Konventsburgen in Deutschordensland Preussen,* München 1998, pp. 124-126.

[9] M. Kutzner, *Propaganda władzy w sztuce Zakonu Niemieckiego w Prusach,* [in:] „Studia Borussico-Baltica Toruniensia Historiae Atrium", v. 2: *Sztuka w kręgu Zakonu Krzyżackiego w Prusach i Inflantach,* ed. M. Woźniak, Toruń 1995, p. 45.

[10] S. Skibiński, *Jeszcze raz w kwestii genezy regularnego zamku krzyżackiego,* [in:] „Studia Borussico-Baltica Toruniensia Historiae Atrium": *Sztuka Prus XIII–XVIII wieku,* ed. M. Woźniak, Toruń 1994, pp. 31-32.

[11] K. Pospieszny, *Der Preussisch-Livlandische Konventshaustyp als eine Kloster- und Herrschaftsidee,* [in:] "Castella Maris Baltici", 6/2004, pp. 156-158.

[12] M. Arszyński, *Technika…*op. cit., p. 103; Ch. Herrmann, op. cit., p. 141.

[13] M. Arszyński, *Technika…*op. cit., p. 107.

[14] M. Łodyńska-Kosińska, op. cit., p. 11.

Quadrangulation method on the example of selected castles from the Chełmno Land

Drawing and designing technique basing on squares, known since at least 13th c., is a method of quadrangulation (*ad quadratum*)[15]. Taking into account regular form of conventual castles, this very method seems to be the easiest way for their designing. The sketchbook of Villard de Honnecourt[16] is the earliest source, documenting application of this technique. Its common use in European gothic architecture was proved by Maria Velte, who subjected to analyses church towers (cathedral), which construction was frequently very complicated[17]. Being aware of techniques introduces in the Middle Ages, it is possible to take up an attempt to reenact the way of designing on the base of the preserved structures' plans[18].

Before starting the analyses of the quadrangulation method in reference to conventual castles, it is necessary to remind briefly its basic assumptions. Designing by this mean is easy, because it requires only the basic knowledge on geometry and the necessary tools consist of compasses and a rope or ruler for drawing straight lines. A builder appointed the first square which was the base for subsequent measures. Next step was to join central points of particular figure sides to obtain next square (inscribed inside) placed by 45° towards the previous one and its surface was half of the previous one. Next, it was to join the middles of the sides of the smaller square. The new one again had a surface twice smaller than the earlier one. These operations were repeated obtaining smaller and smaller figures. Squares made in this way and their sides' lengths defined measures

(lengths) applied not only in drawing a plan, but also height of particular parts of the construction or architectonic details. These squares could also be rotated by 45°, if necessary. It is worth stressing, that in the Middle Ages dimensions were used optionally – there were no universal rules[19].

Having knowledge on the way of creating fundamental dimensions, we can go to more detailed analysis of techniques of their designing using quadrangulation[20]. To make the analysis clear, we accept the following system of their estimating: base square is called square I, every next square (having surface half smaller than the previous one) gets next Latin numeration (square II, III etc.).

1. Papowo Biskupie

In case of this convent house, likewise in the following ones, a base square refers to the biggest figure, by which smaller ones will be appointed, following Roritzer quoted above[21]. Admittedly, Maria Velte proved, that this method can be used also the other way round (tarting with the smallest square), but it would be more difficult[22]. Moreover, taking into consideration space limitation of the building site (hills or area surrounded by water and swamps) it was much more convenient to control the appointed plan starting with general outlining the building size[23]. In case of Papowo castle the contour of convent house closes in a square with a side of 9 rods of old Chełmno measure (Fig. 1)[24]. This square is limited by tops of risalit corner towers (Fig. 3). The obtained figure is for us an initial option for marking subsequent squares. Next, with no II is made from joining middles of square I sides and rotated towards

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[15] More about quadrangulation and triangulation used in sacred buildings of medieval Europe you can find in: J. Gimpel, *Jak budowano w średniowieczu,* Warszawa 1968; M. Łodyńska-Kosińska, op. cit., s. 3-21; *Geometria architektów gotyckich,* „Kwartalnik Architektury i Urbanistyki", IX/1964, z. 2, s. 89-114. Further literature there.

[16] M. Łodyńska-Kosińska, *Geometria…*, op. cit., v. 2, p. 94.

[17] M. Velte, *Die Anwendung der Quadratur und Triangulator bei der Grund- und Aufrissgestaltung der gotischen Kirchen,* Basel 1951.

[18] One must be very careful, however, because inscribing subsequent geometrical figures into the building projection one can be led by wishful thinking. Multiplying geometrical figures on geometrical plans we can always adjust something to it at last.

[19] M. Łodyńska-Kosińska, *Geometria…*, op. cit., pp. 92-94.

[20] Precise projections based on geodetic measurements made by Roman Łopaciuk and PKZ inventories were used in this case.

[21] Ibid., pp. 91-94.

[22] J. Akerman [rec.], M. Velte, *Die Anwendung der Quadratur und Triangulator bei der Grund- und Aufrissgestaltung der gotischen Kirchen,* Basel 1951, pp. 91, "The Art Bulletin", 35/1953, no 2, p. 156.

[23] We have to distinguish drawing a design from projecting the plan onto the building site. In both cases, however, starting drawing from external figure seems to be more probable. Starting in the area with a small square, marking, e.g. a gallery, not situating it precisely in the limited space, wings, drawn in final stage, could have reached with their range outside the embankment or a lake shore.

[24] The old Chełmno measure (1 foot = 31,3 cm) was used in the Teutonic state in 13th c. and the 2nd quarter of 14th c. In 14th c it was superseded by new Chełmno foot, known earlier (1 foot = 28,8 cm, 1 rod = 15 feet); Ch. Herrmann, *Mittelalterliche Architektur im Preussenland. Untersuchungen zur Frage der Kunstlandschaft und –Geographie*, Petersberg-Olsztyn 2007, pp. 113-115.

it of 45º. If we draw two additional squares with size of figure II and place them in opposite corners of the first figure (their sides will be placed in parallel to its sides), we will create next surface of a defined shape in the center of square I, which will be the space of the courtyard without a gallery. Next, according to these fixed rules, basing on square II, drawing square II, we obtain the wall, surrounding the courtyard, thickness, appointed in former act. Next, squares IV and V must be inscribed. The second one defines the space within the gallery and simultaneously determines its width. The measured figures demonstrate some slight deflections in reference to a real castle projection, but they are not significant and can be explained by imperfection of measuring methods in the Middle Ages. Precise marking a structure of this size by the means of chains or ropes could not have been an easy task.

As it was mentioned above, measurements obtained by quadrangulation were not used only in plan designing, but also while estimating a building height or its elements. In case of Papowo castle, figure V was the model square serving for its height defining. Due to the fact, that the castle walls have largely preserved, we are able to estimate the gallery height, which is appointed by an offset on southern wall in northern wing. Knowing this dimension, it turns out, that square V not only appointed the gallery width, but also its height (together with its roof pitch). Square V also served for appointing the elevation height (Fig. 4) with proportions 2 : 4 (1 : 2). Unfortunately, no evidence for the convent house roof height reconstruction has preserved. It may have been marked also by square V, by which the elevation together with the roof could have proportions 3 : 4. Quadrangulation did not probably serve for defining the construction details, like division walls' thickness, room sizes, corner risalites span. Drawing smaller and smaller squares and inscribing them into their plans is possible, but size differences between these diminishing figures become insignificant, by which their adjusting is almost certain. Taking into account these small size differences, it is easy to see

a module, where one wishes to see it. It seems rather senseless, that the builders could have defined spans of particular room this way. It is most probable that their dimensions and wall thickness were defined using traditional foot measures, only precising them in the building erection process.

2. Radzyń Chełmiński and Brodnica

Applying corner towers, conventual house of „classical" period[25] in Radzyń Chełmiński and Brodnica characterize with some similarities to the fortress in Papowo Biskupie. These castles are much more precisely drawn in the area – walls are smooth and angles right. They also differ by application of a new foot and Chełmno rod – in Radzyń Chełmiński the conventual house measures 11,5 x 11,5 (Fig. 2), and in Brodnica – 10,5 x 10,5 of a rod[26]. Despite these differences, it seems that during drawing quadrangulation, these castles used similar model as in Papowo Biskupie (Fig. 5-6). Therefore, both, in case of the castle in Radzyń Chełmiński and in Brodnica, the range of square I is marked by towers' tops[27]. Having drawn square II and using it in analogous way as in case of Papowo Biskupie castle, we obtain internal space of the courtyard without the gallery. Square III next marks thickness of walls surrounding the yard. The building in Brodnica reports diversity from the rule in eastern wing. In this case, a side of square II marks the range of the wing with the gallery. The arcade from this side roomed some halls and a well, and the wing itself was narrower, than the others. This aberrance could have resulted from plan changes or, more probable, from the need of making passage space, which in Brodnica was situated at the side – near the tower, where with the full width, it would have been difficult to move because of the wing and the gallery. Returning to further elements of quadrangulation in designing castle planning in Radzyń and Brodnica, it should be remarked, that one diversity in planning the gallery in reference to the one, presented in Papowo Biskupie is noticeable. Square IV rotated of 45º marked internal front

[25] The term "classical" conventual house was introduced by Thomas Torbus to describe ripe terms of their architectural style. Include strongholds in Gniew, Radzyń Chełmiński and Brodnica. They were built subsequently and differently from less decorative and not that much complicated previous regular strongholds in Chelmno Land; T. Torbus, op. cit., s. 144-176.

[26] These are sizes of the wings only, without corner avant-corps towers.

[27] In case of Brodnica castle, towers' corners do not mark ideal square, but the difference is within 1 foot. It can be explained by the difficulties in making measurements of such a huge construction in the area and do not influence significantly on the result of proportions establishing by the discussed method.

(facing the wings) of the gallery wall. Simultaneously, square IV with lines marked earlier by respectively placed squares II, defined also the width of the gallery porch (at least at the level of ground floor, which must have been more massive than the first floor). Moreover, it can not be excluded, that square V could have served in Brodnica castle for marking the range of the yard space within the arcade. It is not evidenced, though, as the arcade is slightly narrower.

Studying castles in Radzyń Chełmiński and Brodnica, only the first one has preserved the walls, complete enough to enable analysis of the described quadrangulation method in elevation designing (Fig. 7). In case of this construction we are able to define not only the walls' height, but also the roof of southern wing, which is possible due to signs preserved in corner towers. The analysis confirms that while designing Radzyń Chełmiński castle facades, mediaeval architect used the quadrangulation method, giving different proportions than a builder in Papowo castle. Drawing elevation (walls and the roof height), he probably used squares: V, VII and IX. Elevation proportions without the roof are 1,5 : 4 (3 : 8). To mark them, squares VII or the ones possessing twice longer sides – squares V and their halves were used. Applying squares VII, the elevation wall has 3 height squares and 8 width ones, and in case of squares V – 1,5 of the height square and 4 width squares. Appointing the roof height analogical operation was used implementing squares VII and IX. In this case proportions are 1,5 : 8 (3 squares IX of the height and 16 squares IX of the width or 1,5 of square VII of height and 8 of width).

3. Golub (Golub-Dobrzyń)

The method described above is successful in case of castles built on a square plan. However, some of conventual houses erected by Teutonic Order had a plan of a shortened rectangle. The Chełmno Land has such an example in Golub castle. Using quadrangulation method drawing rectangular plan, we can assume using two identical plots with shifting (Fig. 8). In case of Golub castle, the module of square I would be the length of shorter castle side. Quadrangulation drawn this way would mark three sides of conventual house, and the second one – shifted – the fourth one. At this stage, it is difficult to define, what the shift dimension results from. In Golub, it is the distance close to circumferential walls' thickness. Using quadrangulation within these two shifted squares, we obtain results, analogous to the ones presented above, with some diversities. The line marked by square II adjacent to the corner of square I marks only the width of southern wing – the main one. The remained ones are narrower. Due to this fact, square III appoints the wall thickness which closes only the main wing from the yard side. In case of the remained wings, square III appoints their total width. Therefore, the yard space in Golub castle is inscribed into the lines of square III and the dimension obtained from square II (at wider southern wing). Such situating must have been much more time consuming, than the examples presented earlier, but it is possible, because this method served for estimating the wings' width and the courtyard range.

An attempt of the method implementation in other conventual castles in Prussia

Assuming using in the Middle Ages the method of quadrangulation in designing regular conventual castles in The Chełmno Land, it should be considered, if the technique could have also been used in erecting other (older, but also younger) conventual castles from the area of Teutonic Prussia. To check possible range of the technique, the analyses of eight different Teutonic castles' plans were performed. It must be emphasized, that precision of castle plans obtained from literature is not as reliable, as in case of the examples discussed above, and their analyses are of preliminary and general character only. In case of castles in Malbork and Brandenburg, which belong to the earliest regular conventual houses from Prussia territory – in a group of strongholds from the Vistula Lagoon[28], which outlines were, contrary to the later ones, rectangular, the situation is not clear. The quardangulation of these, originally three-winged structures could have been based on similar rules as Golub example. In Malbork, similarly to Golub, the width of the main wing (northern) would be marked by dimension of square II (thickness of its wall from the yard side – square III), and the width of western and southern wings – square III (Fig. 9). Some regularities in appointing the wings' width (square III) can be observed also in Brandenburg. It is not

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[28] T. Torbus, op. cit., pp. 96-108.

certain, if quadrangulation method was employed in these castles' designs. Lines traced by figures are not compatible precisely with the line of walls, as it was in case of Chełmno castles. It can result from neglected accuracy of the projection or mistakes of mediaeval surveyors.

Not making any conclusions as to quadranulation application in designs of all the Vistula Lagoon castles, it is worth analyzing in addition three conventual castles, chronologically closer to the Chełmno Land fortresses, i.e. the castles in Gniew, Świecie and Człuchów. In Tomasz Torbus' opinion, the castle in Gniew could have been designed by the same architect as the castle in Radzyń Chełmiński. He regards Gniew as the first „classical" conventual castle belonging to the same group as Radzyń and Brodnica[29]. However, the attempt of applying quadrangulation method, (like in the Chełmno Land castles) finished with failure. If it is not a result of imprecision in using the projection, Torbus' statement of the same architect seems to be mistaken. Similar negative result was brought trying to use „Chełmno" quadrangulation model in Człuchów castle. The result was positive, on the contrary in case of the castle plan in Świecie (Fig. 10). Quadrangulation figures were compatible to the house plans. The details of applied technique are varied from 'Chełmno' ones, though. Square I was based on sides of the castle wings, because corner towers have circular projection. Middles of those circles are vertices of square I. Different from Chełmno castles, lines marked by rotated and drawn squares II and square III appoint the width of the gallery porches (in the Chełmno Land, they matched the width of circumferential wall surrounding the yard). This analysis seems to confirm this technique using in designing Świecie castle, but in a different way than in the Chełmno Land.

The same attempts were undertaken in case of later conventual castles (Ostróda, Ragneta and Tapiawa). Despite clearly regular plan of these strongholds, the result was negative. Such regular structures must have been designed by the means of geometry, but certainly with varied method.

Summary

Being aware, that while testing some theory, we can solely check, if it was possible and we do not make any reconstruction using the model (although it is suitable), the presented analyses lead us to draw some conclusions:

1) The quadrangulation method seems to have been applied in designs of regular conventual castles in the Chełmno Land (erected from the end of 13th c., till the half of 14th c.).

2) Dimensions obtained in this way served for estimating dimensions of particular construction elements in horizontal and vertical projections.

3) Quadrangulation method was used only in estimating basic structure proportions: width and height of wings, courtyard and the gallery. Smaller elements were measured by the means of standard units (e.g. central towers in Radzyń and Brodnica, windows in Papowo Biskupie).

4) In castles close chronologically and later ones, erected out of The Chełmno Land territory, this method was not used in the same way. Probably other geometrical methods were implemented, with one exception – the castle in Świecie, situated at the Chełmno Land border territory, although the model used there differs slightly from the one under discussion.

5) Taking into account the fact of repeatability of the model application in the Chełmno Land, it can be suggested that these castles were erected by some builders or some subsequent builders generations, exchanging the ideas. Some objects may have been completed by the same architect, or there were existing defined patterns, which have not preserved till our times. Using the quadrangulation method in nearby Świecie could have been the reminiscence of their design activities.

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[29] Ibid., p. 145.

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