Construction of Early Rib-Vaults in Croatia

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Early rib-vaults

Rib-vault played a very important role in the development of Gothic architecture. Although ribs are not primary load-bearing elements of Gothic vaults, as was believed by the 19th century supporters of the theory of “rationalism of medieval architecture” (Alexander, Mark and Abel 1977), they are an integrating member of Gothic structural system (Frankl 1962).

The earliest “rib-vaults of the first generation” were experimental structures, built in various regions of Europe: Lombardy, the Upper Rhine, southern France, Normandy and England at the end of the 11th and the beginning of the 12th century (Nußbaum and Lepsky 1999).

In the first half of the 20th century, it was hypothesized that the Lombard domical vaults with diagonal arches were the earliest rib-vaults in Medieval Europe. Another hypothesis claimed that the first groin-vaults with diagonal arches were constructed in southern France. According to Frankl, the vaults of the choir aisles of Durham cathedral, begun in 1093 and finished in 1096, were the very first vaults with the combination of rib and groin-vault (Frankl 1962, 3). Recent researches have discovered examples of vaults with diagonal arches earlier than the ones in Durham: e.g. the vaults of the aisles of the transept of Speyer cathedral, which were probably built during the remodelling of the church between c. 1082 and 1106 (Frankl [1962] 2000, 57, 307).

In the European history of construction, the examples of early rib vaults in Croatia have not been mentioned, although some very early and very interesting examples have been preserved.

Tradition of vaulting in Croatian early medieval architecture

In the Mediterranean part of Croatia, a relatively large number of pre-Romanesque churches has been preserved, mostly buildings of a very small scale. Because of the variety of their plan types and their often complex composition of volumes, they were considered an original achievement of local early medieval builders (Karaman 1930; Mohorovičić 1957; Strzygowski compared them to the Early Christian Armenian churches (Strzygowski 1927), and Dyggve considered them a derivation of early Christian religious buildings of various types, in which the Croatian coast abounded (Dyggve, 1951). Goss points up the differences between the “traditional pre-Romanesque group” of buildings, following the models of earlier local architecture, and the “early Romanesque group”, featuring new structural and formal elements (Goss 1996).

All the preserved early medieval churches in Croatia were built in stone. As a rule, they are vaulted with various types of domes, semidomes, barrel vaults and groin-vaults. (Gvozdanović 1969, 28)

Domes with diagonal arches – a new element in the traditional type of vaulting

Among the small medieval churches with the so-called free plan, characteristic of the pre-
Romanesque architecture in Croatia (Karaman 1930), two churches are specific for their vaulting: the church of Sv. Nikola [St. Nicholas] near Nin in northern Dalmatia and the church of Sv. Krševan [St. Chrysogonus] on the island of Krk. The spatial concept of these churches is almost identical, and so are their dimensions: St. Nicholas near Nin is only 7.30m. long, and St. Chrysogonus is slightly longer – 7.85m. (Marasović 2009). Both churches have a “trefoil” plan, i.e. a cruciform scheme with three semicircular radiating apses, vaulted with semidomes. Their fourth, western arm has a rectangular plan. In St. Nicholas this entrance space is also vaulted with a semidome, carried on the conch-shaped squinches in the corners (Jackson 1887, 1: 342), while in St. Chrysogonus the western arm is covered with a barrel vault.

The important feature that differentiates these two medieval churches from a number of similar small pre-Romanesque churches are the massive diagonal arches of their domes, constructed on the irregular cylindrical drums above their central “crossings.” In both churches the arches of the dome lean on four pilaster strips, projecting from the corners where the walls of the four arms meet. The thick walls are built in roughly coursed rubblework. The pilaster strips are built of cut stones. The diagonal arches with rectangular cross section spring from their broad “capitals” made of fragments of classic moulding (Jackson 1887, 1: 342). In St. Nicholas the arches are constructed of ashlar blocks, and in St. Chrysogonus they are built with smaller hewn stones bordered with larger, better cut stones on the edges. At the crown of the dome, where the arches intersect, one arch is continuous, while the other one is constructed of two segments leaning against the first arch. This detail clearly shows that one arch was erected first, as a whole continuous arch, and the other one was built later.

The domes are constructed with roughly hewn stones. The transition from the cubic central spaces of these churches to their approximately hemispheric domes is achieved in the specific way: the undressed stones are laid in roughly concentric circular courses in the upper part, and in the lower part the form of the domes gradually adjusts to the approximately square plan of the crossings of the churches. This is an unskilled but inventive attempt to blend the circular form of a dome with the nearly square plan of the central crossing – without using squinches, which are often used in Croatian pre-Romanesque architecture, nor pendentives. This form does not belong to the sail-dome type either. The small domes with intersecting arches differ from concrete Roman domes, from Byzantine brickwork ribbed domes, and from Lombard Romanesque domical rib-vaults.

The Lombard early rib vaults are groin-vaults with diagonal arches; their domical form is the consequence of the semicircular form of their transverse and longitudinal boundary arches as well as of the diagonal arches, which have a longer span and consequently higher rise. The domes of St. Nicholas and St. Chrysogonus have different geometry: they are real domes, their departure from the hemispherical form being the consequence of specific adaptation of the spherical form to their cubic substructure. However, it is not impossible that the builders of the tiny Croatian churches, with limited budget and skills, tried to imitate the Lombard vaults, but did not understand their geometry, and thus tried to approximate it with the dome – the form they were familiar with. In spite of the obvious lack of skill of their builders, the structural concept of St. Nicholas and St. Chrysogonus is clear and logical: semidomes of the apses, placed immediately under the central dome, take over the thrust of the dome.

The problem of diagonality, which arose with the introduction of diagonal arches in the earliest buildings with rib-vaults (Frankl 1962), is not an issue in these churches with a basically cruciform plan: the pilaster strips, projecting from the corners of the central space, on the contact of the radiating aisles, are set radially, i.e. in the direction of the diagonal arches. The solution is so logical and simple that it can be taken for granted, but one should compare how the problem of diagonality was coped with in other buildings with early rib-vaults.

There are no historic sources on the construction of these buildings and no formal elements that could accurately define the period of the building of the two churches, obviously so akin
in spatial and structural concept and construction method. According to Jackson, St. Nicholas near Nin "might be attributed with almost equal probability to any time from the ninth to the twelfth century; but the cross-ribs that underlie the dome seem to me to point rather to the later than the earlier part of that extended period" (Jackson 1887, vol. 1).

Regarding the spatial concept, the material used and the method of construction, St. Nicholas and St. Chrysogonus belong to the long tradition of small centrally-planned pre-Romanesque churches in the Mediterranean part of Croatia. Therefore they were considered pre-Romanesque buildings by Karaman [1930] and Mohorovič [1957], as well as by Gunjača, who dated them in 9th to 10th century (Gunjača 1948). The unusual feature of the arched dome led several researchers to the hypothesis that the arches were added to the pre-Romanesque structure in the later remodelling (Vasić 1922).

Recent researches carried out on the structure of St. Chrysogonus have proved that the diagonal arches are the integral part of the original structure, constructed together with the hemispherical dome shell (Fučić 1998). Therefore the whole structure has to be considered an early Romanesque building and dated in the 12th century (Marasović 2009). This applies also to St. Nicholas near Nin (Petričioli 1990; Goss 1996; Marasović 2009).

Vault in the bell-tower in the Benedictine convent in Zadar

The most elaborate early vault with diagonal arches in the Mediterranean part of Croatia is the vault in the bell-tower of the church Sv. Marija [St. Mary] in the Benedictine convent in Zadar. Unlike the vaults in the rustic churches of St. Nicholas near Nin and St. Chrysogonus on the island of Krk, this vault is erected in a representative building: the bell-tower built in honour of the solemn entrance to Zadar of king Colomannus [Kalman], the first king of Croatia who belonged to the Hungarian Arpad dynasty. The inscription on the walls of the bell-tower records this event and gives precise evidence of the beginning of construction of the tower: ANNO INCAR

DNI NRI IHV XPI MIL C V, i.e. the year 1105 (Jackson, 1887 1: 298).

The two lower storeys of the bell-tower, preserved in the original state, were completed by 1111, together with the adjoining Romanesque chapter house, which is structurally and functionally connected with the tower (Petričioli 1968; Jurković 2000, 35). The room on the first floor of the bell-tower is accessed from the chapter house and has an opening which used to give access to the former balcony which overlooked the chapter house. The small room in the bell-tower, square in plan, is adorned with four columns in the corners and fine Romanesque frescoes (Petričioli 1968, 85). The columns have cushion capitals and richly carved impost, which connect them to the masonry of the walls. Sophisticated design and decoration of the room and its close functional connection with the chapter house indicate that this was planned as the gallery of the king Colomannus (Jurković 2000; Marinković 2004, 53, 56-57), whose name is carved on the four capitals: R. CO-LLO-MAN-NUS (Jackson 1887, 1: 307).

The most important feature of this small room is its vault: a groin-vault with massive diagonal arches. The arches, rectangular in cross section, spring from the impost of detached columns in the corners. The arches are broad, constructed with precisely cut stone blocks, laid in regular courses, similar to building technique of ashlar walls. The solution of the arch intersection is simple: one arch is continuous, and the other one consists of two parts, which lean onto the first arch. This constructional detail is characteristic of the earliest medieval rib-vaults built in various regions of Europe (Nussbaum and Lepsy 1999, 28).

The diagonal arches are nearly semicircular in form; the contour line of the vault webs on the wall is also semicircular. The use of the semicircular form for diagonal arches and for orthogonal boundary arches [in this case boundary arc] usually results in vaults with rising ridges, e.g. early Lombard domical rib-vaults. The vault in the bell-tower of the Benedictine convent in Zadar, on the other hand, has horizontal ridges. This specific solution is the result of the elaborate design of the room in this bell-tower: the columns in the
corners reduce the span of the diagonal arches. As the room is very small, this reduction is relatively important, so that the span of the diagonal arches is nearly equal as the length of the sides of the room.

The slender detached columns take only a small portion of the vertical vault load; the horizontal thrust of the vault being transferred by the vault web directly to the massive walls and stabilized by the weight of the high walls of the bell-tower.

The detached columns in the corners might have been inspired by the ancient Roman architectural tradition of columns without structural function set for decorative purpose in front of walls, as can be seen in the mausoleum of the emperor Diocletian in Split. The solution of crossing of the arches without a keystone, but with one continuous arch and the other one consisting of two arms, might also point to the Roman model: the crypto-ribs of Roman groin-vaults, which were constructed in the same way. These brick ribs, used as a permanent centering, were invisible in completed plastered vaults (Frankl 1962), but they might have been visible in ruinous ancient buildings of Zadar, which was in ancient times one of the most important urban centres of the Roman province of Dalmatia. The vault in the bell-tower in Zadar, a royal donation, constructed by excellent builders and stonecutters, is an inventive solution to the problems faced by the master-builders at the beginning of the 12th century.

Vault in the chapel in the episcopal complex of the town of Krk

Sv. Kvirin [St. Quirinus] is a Romanesque double-storied chapel in the episcopal complex of the town of Krk on the homonymous island. The chapel was built in front of the west façade of the cathedral of Krk and was connected to the cathedral with a wide opening in the upper storey (Jurković 1992). The upper storey of St. Quirinus has a longitudinal plan with nave and two aisles; its presbytery is composed of three semicircular apses – a plan often used in Romanesque architecture. On the ground floor the church has only a nave and the western aisle, the eastern aisle being sacrificed for an important medieval street which gives access to the main entrance of the cathedral. This street has been very important since the Roman times: it was the ancient cardo of the splendidissima civitas Curricaturn (Mohorovičić 1957).

The church of St. Quirinus is built in excellent ashlar masonry. The lower storey is vaulted: the apses with semidomes, and the three bays of the side aisle with groin vault, which also covers the first and the third bay of the nave. In the second, “central” bay of the nave vault, massive diagonal arches are added to the groin vault. These arches are constructed of ashlar, with two or three squared stone blocks in each horizontal course, similarly to wall masonry.

In the crossing of the arches, one of them is built as a continuous arch, and the other one is composed of two parts, leaning onto the first built arch – like the crossing of arches in the Zadar bell-tower and in the small churches of St. Chrysogonus and St. Nicholas. The diagonal arches, as well as massive transverse and longitudinal arches of the vault, rest on short massive pillars. The diagonal arches constructed only in the “central” bay, seem to have primarily an aesthetic role: to emphasize the central bay. According to the research in situ, the church was built at the end of the 12th century (Mohorovičić 1971, 32).

Specific solutions of early rib-vaults in Croatia

In the period of constructional experiments at the end of the 11th and the beginning of the 12th century, when characteristic features of Gothic structure were conceived within Romanesque architecture, a new structural element – diagonal arch – was also introduced in several vaults in the Mediterranean part of Croatia. The shape of these vaults differ: the representative room in the bell-tower of the Benedictine convent in Zadar and the “central” bay in the lower storey of the chapel of St. Quirinus in the episcopal complex of Krk are covered by groin vaults with diagonal arches – the new progressive form of vaulting, developing at the time in various European centres.

In the rustic churches of St. Chrysogonus on the island of Krk and Sv. Nicholas near Nin,
diagonal arches are introduced into the dome, a traditional form of vaulting in Croatian pre-Romanesque churches. The builders of these small churches applied the imported solution in their own way, creating an unorthodox combination which nevertheless has its inherent logic and fits the traditional cruciform substructure. The use of new structural elements within a conservative context indicates an influence of a progressive centre, pointing to the Lombard domical rib-vaults as the most likely model. However, the arches of the dome of St. Nicholas near Nin, not far from Zadar, could well have been inspired by the rib groin-vault in the bell-tower of the Benedictine convent in Zadar.

In all preserved early rib-vaults in the Mediterranean part of Croatia, the diagonal arches are broad, massive, rectangular in cross section, and constructed in the same technique, characteristic of the very early stage of the development of rib-vault. The diagonal arches are built in coursed stone masonry, without keystones. The detail of the arch intersection is simple: one arch is continuous, and the other one consists of two parts, which lean onto the first arch. This constructional detail is characteristic of the earliest medieval rib-vaults built in various regions of Europe (Nussbaum and Lepsky 1999, 28).

The early date of the vaults with massive diagonal arches is corroborated by the precisely dated vault on the first floor of the bell-tower of the Benedictine convent in Zadar. The construction of the bell-tower and the adjoining chapter house is exactly dated with the original donor’s inscriptions in the period 1105-1111, which makes it one of the earliest precisely dated rib-vaults in Europe. The concept of the vault and its substructure, with slender detached columns in the corners, which reduce the span of the diagonal arches, results in horizontal ridges of the vault webs. This original solution differs from the Lombard early rib-vaults with rising ridges and testifies to the high skill of the masters. The technique of construction of the vault arches and the detached columns show that the traditions of the ancient “ars aedificatoria” were still alive in Zadar, ancient Roman colony of Iader.

The vault in the chapel in the episcopal complex in Krk was built later [probably at the end of the 12th century], but it was constructed in the same technique as the one in the Zadar bell-tower. It also has horizontal ridges, but they are achieved in a different way, with elliptical diagonal arches springing from the short massive pillars. The vault in the Krk chapel has diagonal arches only in its “central bay,” and other bays are covered with a groin vault. This proves that its builders were aware of the primarily aesthetic function of the ribs. The vault in the Krk chapel shows similarity to the vault in the Zadar bell-tower rather than the Lombard domical vaults. As the vault in the Krk chapel was built almost a century later, the persistent use of the specific solution might hint at a local school.

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