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Publisher: Routledge
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Archaeological Journal

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/raij20>

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Published online: 17 Jul 2014.

To cite this article: John Bilson D.Litt. F.S.A. (1922) Durham CathedralThe Chronology of its Vaults, Archaeological Journal, 79:1, 101-160, DOI: [10.1080/00665983.1922.10853386](https://doi.org/10.1080/00665983.1922.10853386)

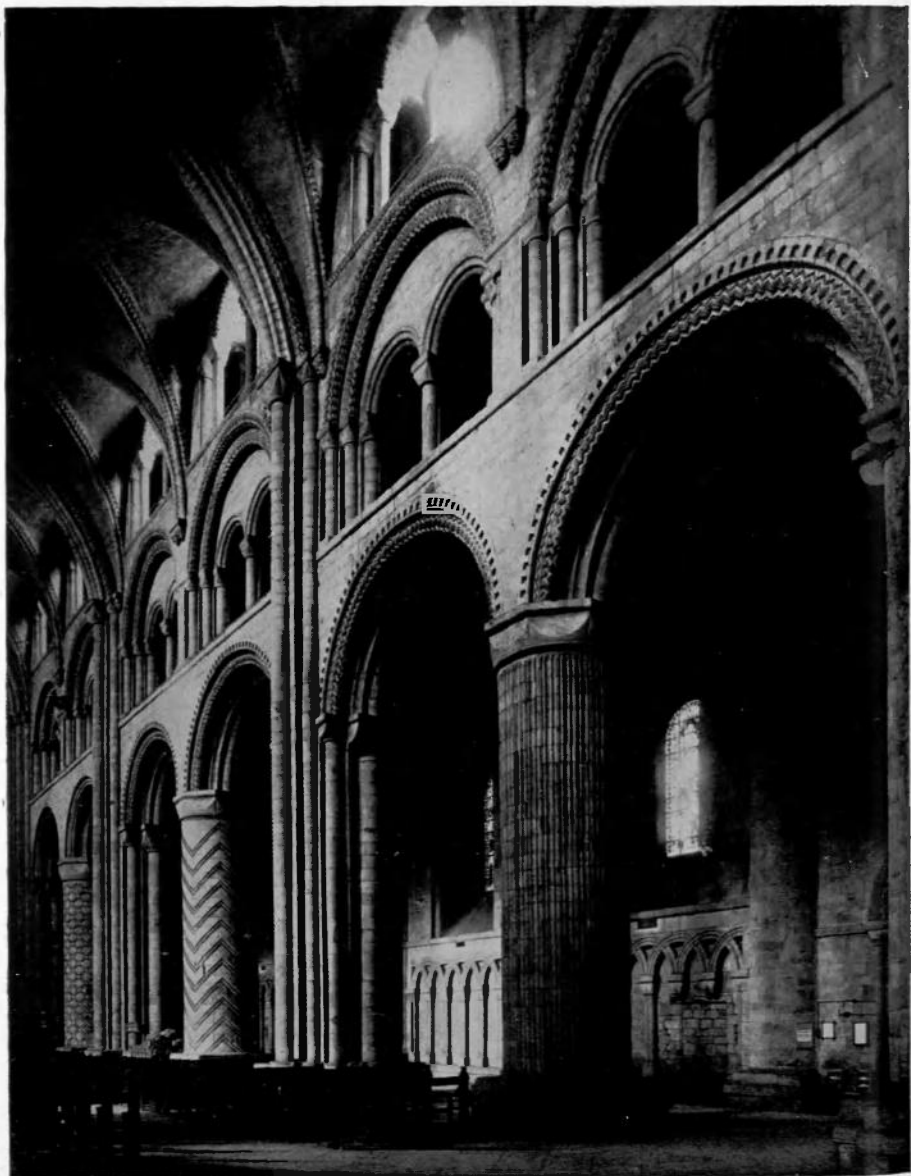
To link to this article: <http://dx.doi.org/10.1080/00665983.1922.10853386>

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[E. Lefèvre-Pontalis, photo.]

NAVE, SOUTH SIDE.

DURHAM CATHEDRAL
THE CHRONOLOGY OF ITS VAULTS

By JOHN BILSON, D.LITT. F.S.A.

The cathedral church of Durham is justly recognized as the culminating achievement of the Norman Romanesque school in England. Its majestic interior owes much of its monumental character to its vaults. The chronology of these vaults is therefore an important element in the history of the building. It is even more important in its bearing on the more general question—what was the contribution of the Norman school to the solution of the structural problem of covering with stone vaults the aisled church with a clearstory.

The Durham vaults were either ignored or entirely misunderstood by most writers of the last century, and the nave vault was generally attributed to the middle of the thirteenth century—an amazing blunder. The credit of correcting these errors and of establishing the history of the vaults on a sound basis is due to the late Canon Greenwell, who published an address which he had delivered in 1879 in the first edition (1881) of his admirable little book on the cathedral. It was at his suggestion that I began my studies of the general question, the results of which were published in 1899.¹ In this general survey, the vaults of Durham naturally had an important place. They were described in detail, and some reasons were given for the dates assigned to them. The conclusions then set out have been confirmed by subsequent study, which has shown that the building itself affords complete proofs of the precise relation of the vaults to the walls from which they spring. Some of these proofs (though not all) have been published in the course of the discussion which followed the publication of the paper. The scaffolding of the nave

¹ *The Beginnings of Gothic Architecture: Norman vaulting in England*, in the *Journal of the Royal Institute of British Architects*, 3rd ser. vi, 289, 345 (also issued by the R.I.B.A. as a separate publication). Translation in

the *Revue de l'Art Chrétien* for 1901, pp. 365, 463. The references below to the *Journal R.I.B.A.* are all to volumes in the third series.

vault for repair in 1915 afforded a very exceptional opportunity for a close examination and survey, the results of which appear to deserve publication. And as much that has already been published is scattered in various communications, it seems to me that the advantage of a connected story including all the evidences is sufficient to justify a return to the subject, even though this may involve some repetition of what has already been published elsewhere.

In order to understand how such a masterpiece as Durham came to be begun in 1093, it is necessary to realize that the preceding years were times of extraordinary activity in church-building. When Lanfranc became archbishop of Canterbury in 1070, he found his church in ruin, and at once set about the building of a more noble one, which he completed in seven years. His example was followed by the newly introduced bishops and abbots. The following list of some of the greater churches which we know to have been begun before Durham is sufficiently impressive: the cathedral churches of Canterbury, Lincoln, Rochester, Winchester, Ely, London (St. Paul's), Worcester, and Chichester; and the abbey churches of Canterbury (St. Augustine's), St. Albans, Bury St. Edmunds, Gloucester, and York (St. Mary's). Such an extensive field of activity afforded the fullest scope for the energies of all the master-masons who could be brought over from Normandy, and it is in the earliest churches which were built after the Conquest that we find the completest adoption of the manner of the mainland. A little later there is a less close adherence to the type, sometimes more irregularity in progress, and sometimes less uniform realization of the logic of construction in different buildings, which is explained by the fact that the movement was not of native origin. Nevertheless the great extent of building and the wide field of experience produced conditions which were favourable to the emergence of masters of exceptional ability, and such undoubtedly was the great master who was selected to plan and begin the new cathedral of Durham.

What we know from documentary sources of the dates of the building of Durham cathedral is derived almost entirely from Symeon's *History of the Church of Durham*

and its continuation.¹ Symeon's name occurs as thirty-eighth in his own list of the earliest monks of Durham, Algar who became prior in 1109 being forty-ninth, and Roger who became prior in 1139 being sixty-seventh.² Symeon was present at the great translation of the body of St. Cuthbert in 1104.³ His history of the church seems to have been written between 1104 and 1108; it ends with the death of bishop William in 1096. Its continuation ends in 1144. The more important passages which refer to the building of the cathedral are quoted below.⁴ In the original manuscript at Durham, the continuation seems to be in two hands, the earlier of which ends immediately before the record of Flambard's death, but the whole of the continuation, which was the work of a Durham monk or monks, appears to be practically contemporary with the events which it records.⁵ The statements which we find in Symeon's History and its continuation with regard to the building works were thus written by monks who lived on the spot and were recording matters within their own knowledge. The evidence therefore, as far as it goes, is incontrovertible.

William of Saint-Calais, the bishop who began the building, was originally a secular priest of the cathedral church of Bayeux, and afterwards entered the monastery

¹ *Symeonis Monachi Opera Omnia*, ed. Thomas Arnold, 2 vols. (Rolls Series, 75).

² *Ibid.* i, 5-6.

³ *Ibid.* i, 34-35. *Reginaldi Monachi Dunelmensis Libellus* (Surtees Soc. i), cap. xl, p. 84.

⁴ 'Nec multo post ecclesiam, xcvi. anno ex quo ab Aldhuno fundata fuerat, destrui praecepit, et sequenti anno positus fundamentis nobiliori satis et majori opere aliam construere coepit. Est autem incepta mxciii. Dominicae incarnationis anno, pontificatus autem Willelmi xiiii, ex quo autem monachi in Dunhelmum convenerant xi, tertio Idus Augusti, feria v. Eo enim die episcopus, et qui post eum secundus erat in ecclesia, prior Turgotus, cum caeteris fratribus primos in fundamento lapides posuerunt. Nam paulo ante, id est, quarto Kal. Augusti, feria sexta, idem episcopus et prior, facta cum fratribus oratione ac data benedictione, fundamentum coeperant fodere. Igitur monachis suas officinas aedificantibus, suis episcopus sumptibus ecclesiae opus faciebat.'—*Symeon* (ed. Arnold), i, 128-9.

Of Flambard the continuator says: 'Circa opus ecclesiae modo intentius, modo remissius agebatur, sicut illi ex oblatione altaris et coemiterii vel suppetebat pecunia vel deficiebat. His namque sumptibus navem ecclesiae circumductis parietibus, ad sui usque testudinem erexerat. Porro praedecessor illius, qui opus inchoavit, id decernendo statuerat, ut episcopus ex suo ecclesiam, monachi vero suas ex ecclesiae collectis facerent officinas. Quod illo cadente cecidit. Monachi enim omissis officinarum aedificationibus, operi ecclesiae insistent, quam usque navem Rannulfus jam factam invenit.'—*ibid.* i, 139-140.

After Flambard's death: 'Vacavitque episcopatus per quinquennium. Eo tempore navis ecclesiae Dunelmensis monachis operi instantibus peracta est.'—*ibid.* i, 141.

⁵ Mr. Arnold thinks that the continuation was probably written not long after the restoration of peace and order which followed the installation of bishop William of St. Barbara in 1144 (*Symeon*, i, xxiv, 135 note).

of Saint-Calais, in Maine, of which he became prior. He was abbot of Saint-Vincent, Le Mans, when the Conqueror appointed him bishop of Durham in 1080.¹ His predecessor, Walcher, the first bishop of Norman appointment, had intended to substitute monks for the secular clergy of the cathedral, and had actually commenced the foundations of monastic buildings² when he was murdered at Gateshead. As soon as William became bishop, he devoted himself to carrying out this scheme, which was thoroughly in accordance with the policy of ecclesiastical reform initiated in England after the Norman Conquest by the king and archbishop Lanfranc; and in 1083 he settled monks from Jarrow and Wearmouth at Durham.³ Although he was high in the counsels of the Conqueror, and became the chief minister of his son William Rufus on his accession, he was implicated in the revolt against the king and driven into exile in 1088. He passed three years in Normandy, where duke Robert entrusted him with an important part in the administration of the duchy, and in September⁴ 1091 he was restored to his see. Soon after his return from exile, he caused to be pulled down the church which bishop Aldhun had built a century before, and in the following year (1093) he began the erection of a larger and nobler structure. Whatever may be thought of some aspects of his public career, he was a wise and skilful administrator of his church. Although there is no reason to attribute to him the rôle of a monk-architect, he deserves the credit of initiating the general building scheme, and of selecting a master of genius to undertake the work.

The foundation-stones of the new church were laid on August 11, 1093. We have no documentary evidence as to the progress of the work when bishop William died on January 2, 1096, but we are told that, when Ranulf Flambard became bishop in 1099,⁵ the work had advanced as far as the nave. The eastern part of the church was so far completed in 1104 as to permit the translation of the incorrupt body of St. Cuthbert to the shrine behind

¹ *Symeon*, i, 119, 170. William was consecrated bishop on 3 Jan. 1081.

² *Ibid.* i, 113.

³ *Ibid.* i, 120-2.

⁴ Or November (*Eng. Hist. Rev.* xxxii, 386).

⁵ Nominated to the see May 29, consecrated June 5, 1099.

the high altar. Flambard proceeded with the works *modo intentius modo remissius*, and when he died on September 5, 1128, he had carried up the nave *usque testudinem*. In the interval between his death and the accession of bishop Geoffrey Rufus in 1133, the monks completed the nave.

In addition to these facts, we may gather something from a consideration of the resources which were available for the building. When bishop William had settled monks at Durham we can scarcely doubt that he contemplated the rebuilding of his cathedral church, as so many bishops of his time had done or were doing, and that by the time that the work was begun he must have accumulated ample funds for the work. We are expressly told that he carried out the works at his own cost, while the monks went on with the monastic buildings. When his death put an end to this agreement, the monks devoted themselves to the work of the church.¹ There was therefore a first period of nearly two and a half years when the resources were ample, and would permit rapid work. This was followed by a period of more limited means. The progress during Flambard's episcopate was spasmodic, depending on the funds available *ex oblatione altaris et coemiterii*, for, although the continuator recounts Flambard's gifts to the church, he does not indicate that this bishop followed his predecessor's example in spending his own money on the building. Indeed from one of the charters of restitution² which Flambard granted just before his death, it would seem that these oblations *altaris et coemiterii* rightly belonged to the monks. We shall find that these conditions are reflected in the story of the building as its architecture reveals it to us.

The plan³ itself is indeed a masterly production. It shows the expansion which is characteristic of some of

¹ The continuator of Symeon records that, during the vacancy in the see, while the king (Rufus) took three hundred pounds yearly from the bishopric, he took nothing from the monks, but was liberal and beneficent to them, and protected them from oppression and injury (*Symeon*, i, 135).

² This charter is printed in *Historiae Dunelmensis Scriptores Tres* (Surtees Soc. 9), p. xxx, and in *Fedarius Prioratus Dunelmensis* (Surtees Soc. 58), p. 145.

³ For the plan and full illustration, see *Architectural Illustrations and Description of the Cathedral Church of Durham*, by R. W. Billings, London, 1843. The plan (fig. 1) here reproduced omits the later Galilee and Nine Altars, and shows the original east end as indicated by the remains discovered in 1895 (*Archaeological Journal*, liii, 1). On this plan the piers are numbered longitudinally from the west, odd numbers on the north side and even numbers on the

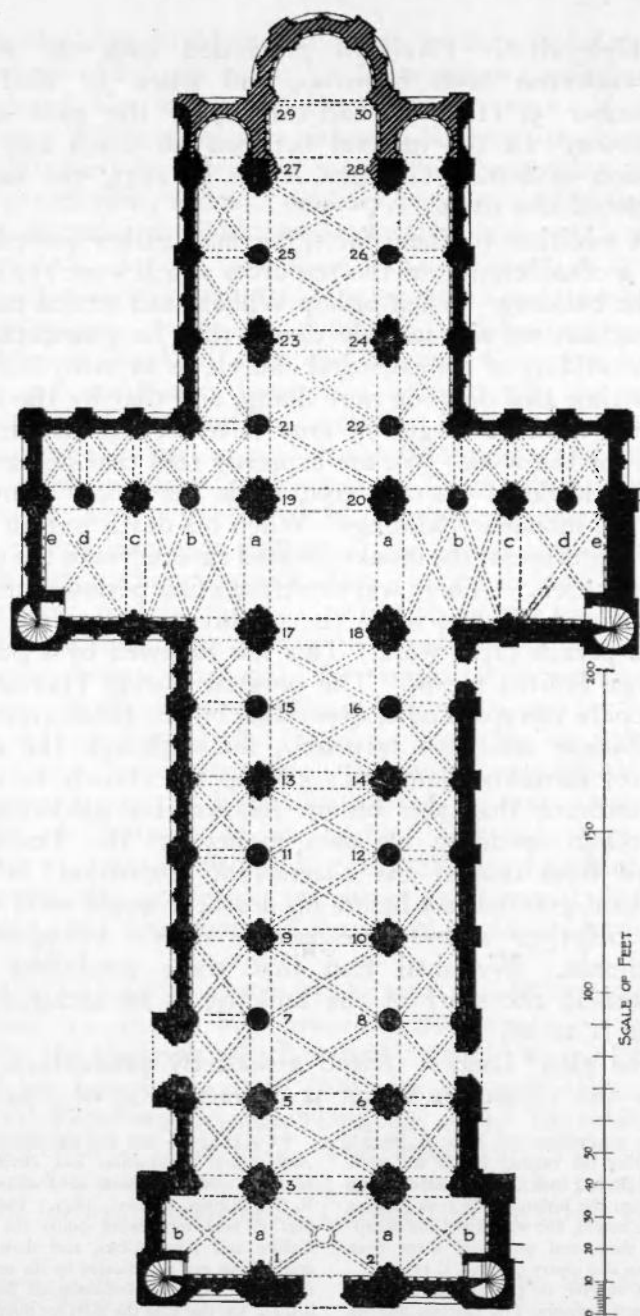


FIG. I. PLAN.

the greater churches in England, as compared with their prototypes in Normandy.¹ In the latter, the eastern arm is usually two bays in length; at Durham, as earlier at St. Albans, this is increased to four bays. In the Normandy plans of this type, the depth of the apses which terminate the aisles, and are finished square externally, corresponds with a broad arch between the choir and its apse.² At Durham (developing further what had been done at St. Albans) a whole bay is interpolated between the choir and its apse, and the depth of the aisle apses is correspondingly increased. The initial scale is much the same as that of the larger churches of Normandy and England, the clear width within the walls of the choir being 32 feet 8 inches,³ and of the choir and aisles 77 feet 2 inches.⁴ The unit of wall and pier thickness is 7 feet.⁵ The transept shows the great development of length which is characteristic of some of the greater churches in England, though its internal length (171 ft. 9 ins.) is a little less than St. Albans (175 ft. 5 ins.) and Ely (178 ft. 6 ins.), and very much less than Winchester.⁶ As at Winchester and Ely, each arm has an arcade and aisle of four bays, but, unlike them, it has no western aisle. Only in the nave is length restricted. A nave of eight bays (instead of the actual seven) up to the western towers, as in Saint-Étienne, Caen, would have completed the double-bay plan more satisfactorily, but it is probable that the conditions of the site limited the length westward.⁷

The internal elevation of the choir shows great distinction and monumental character. Its double-bay

south side, and lettered a, b, c, d, e transversely, so that any pier or bay can be identified by a simple combination of numbers and letters.

¹ *Archaeologia*, lxii, 554 ff., and the comparative plans in *Archaeological Journal*, liii, 17, pl. iii.

- Cf. Lincoln, *Archaeologia*, lxii, 547, pl. lxxv.

³ Internal widths: Jumièges (choir) 31 ft. 2 ins. Saint-Étienne, Caen (nave) 32 ft. 10 ins. St. Albans (nave) 30 ft. 11 ins. Winchester (choir crypt) 34 ft. 2 ins. For other comparative widths, see *Archaeologia*, lxii, 555.

⁴ Internal widths including aisles: Jumièges (nave) 66 ft. 6 ins. Saint-Étienne, Caen (nave) 73 ft. 6 ins. St.

Albans (nave) 75 ft. Winchester (choir crypt) 82 ft. 3 ins.

⁵ Where the foundations have been exposed, it has been found that the walls are built on wide foundations of masonry carried down to the solid rock (*Archaeological Journal*, liii, 8; *Proc. Soc. Antiq.* 2nd ser. xxii, 423).

⁶ The transept in the earlier churches is shorter: Jumièges 123 ft. 1 in. Saint-Étienne, Caen 124 ft. 6 ins. Lincoln 122 ft. 9 ins.

⁷ The position of the transept was doubtless fixed by the monastic buildings, some parts of which had already been built by the monks during bishop William's exile (*Symeon*, i, 128; *Proc. Soc. Antiq.* 2nd ser. xxii, 418 and plan.

system derives from the nave of Jumièges, with its shafted major piers alternating with cylindrical minor piers. Here the structural organization is naturally more advanced than in the much earlier building, and this advance is shown especially in the complete preparation for vaulting both the aisles and the main span. The tall proportion of the arcade stage compared with the height of the triforium also follows the nave of Jumièges, in contrast with the two nearly equal stages of the nave of Saint-Étienne, Caen, and its derivatives. A small but significant detail, because not very common, which confirms the filiation from Jumièges is the projecting band with a quirked chamfer on its upper and lower edges,¹ which runs above the plinth under the external wall-arcade of the choir aisles,² beginning with the earliest work from the east, and inside the church is introduced between the plinths and bases of the main piers³ on the east side of the crossing and transept, and continued westward. At Jumièges this band can be seen on the west side of the crossing.

It seems to be certain therefore that the master who began Durham knew something, directly or indirectly, of Jumièges. The severely logical character of his work proves that he was a Norman. One fact however seems to indicate that he did not come direct from Normandy to Durham. He did not use the volute capital which was then in almost universal use in Normandy,⁴ but the cushion capital which was then practically unknown there. There is therefore reason to believe that, before he began Durham, he had been employed on one of the greater churches in England—such, for example, as Winchester, where the monks entered the part of their church which had then been finished in the spring of the year in which Durham was begun. It is true that modern writers have asserted that bishop William brought with him from Normandy a plan for his new cathedral,⁵ but there is not the least authority for the statement. Moreover, so far as we know, none of the churches which had then been built in

¹ *Billings*, pl. 57.

² *Archaeological Journal*, liii, 8 (fig.).

³ *Billings*, pl. 48, 49, etc.

⁴ The very few volute capitals in the internal wall-arcades of the first work, though of Norman inspiration, are not

exactly like the Normandy capitals of this time, nor like the purely Norman capitals in the chapel in Durham castle, which was built some fifteen or twenty years before the cathedral was begun.

⁵ *Dict. Nat. Biog.* under Carilef.

Normandy showed the expansion of choir and transept plan which we find at Durham and in some of the greater churches in England which preceded it. The more immediate precedents for the plan of Durham are therefore to be found in England rather than in Normandy. Nevertheless it may be well to repeat—what I have often said before—that the structural development of which Durham is the most notable example was purely Norman, and that it was due simply to the conditions in England which were the result of the Conquest that the most remarkable evidence of the Norman advance in the latter part of the eleventh century is to be found in England rather than in Normandy itself.

The story of the building of the church must of course be based on the few facts which are recorded by the chroniclers cited above, which must be interpreted by the evidence of the building itself. We have seen that during the first period of nearly two and a half years, from the beginning of building in August 1093 to bishop William's death in January 1096, the bishop had undertaken the works on the church, and his energetic character and ample means would ensure rapid progress, of which the building itself affords confirmation. We do not know how far the work had progressed when the bishop died, but the design of the first master-mason was continued practically unaltered¹ from the eastern arm into the transept, as far as the top of the triforium on the eastern side of both arms.² The later parts of this first section of the work must, I think, have been built by the monks after the bishop's death, but it was not until the east side of the transept had been so far built that they introduced any serious modification of the first conception.

¹ Except in such small details as the plinth band mentioned above, and in the substitution in the transept triforium over the minor piers of double vaulting shafts for the triple shafts in the choir.

² In my previous paper (*Journal R.I.B.A.* vi, 296) I adopted the then accepted view that the east side of the transept up to the top of the triforium had been built before the bishop's death. It does not however seem to be possible that so much can have been built in so short a time. Nor is there

any reason to suppose that the death of the bishop would coincide with the completion of a definite section of the work recognizable in the building; the employer was changed, means were doubtless less ample, and progress less rapid, but that is all. There is no indication that the bishop's death caused any interruption of the work, and I think we must conclude that the monks continued his work without any modification up to the point mentioned above.

We are told that, when Flambard became bishop in June 1099, the work had advanced as far as the nave, but this may not mean more than that something of the lower part of the west side of the transept and crossing had been built.¹ Canon Greenwell suggested that the monks built the west side of the transept during the vacancy in the see, and he remarked that the simpler and less ornate character of the work seemed to indicate that the funds at the disposal of the monks were not equal to those of the bishop.² This consideration would doubtless apply, even if much of these west walls was built after Flambard's accession, for it is unlikely that resources would then become more ample, at any rate in the earlier years of his episcopate. The simple character of the extreme bays of the west walls of the transept (17 b c e, 18 b c e)³ is due to some extent to the fact that there is no aisle on this side, and therefore no great arcade or triforium gallery, only a wall-passage. The character of the openings in the triforium stage of these bays, with their columns built in beds (instead of monolithic shafts), does however indicate a different handling from that of the first master, though these bays are part of the same build as the bays next the crossing (17 a b, 18 a b), where the arches into the nave aisles have the normal detail, and the triforium openings follow the earlier design, except that the outer order of the arch is not moulded and has no shaft to receive it. The omission of the vaulting shafts in the triforium stage may foreshadow the abandonment of vaulting, though such lapses from strict logic are very common in England. But when we come to the clearstory stage of the south transept, we find clear proof that the idea of vaulting had been abandoned, for on both east and west sides the simple tall continuous arcade is obviously designed for a ceiling of wood. This abandonment of vaulting can scarcely have been due to timidity,⁴ for as we shall see, the choir did actually receive

¹ Here again there is no reason to suppose that the completion of the usual abuttal section of the nave west of the crossing would coincide with the consecration of Flambard.

² Greenwell, *Durham Cathedral* (1897 edn.), 34.

³ Billings, pl. 14; *Journ. R.I.B.A.* vi, 259 (photo).

⁴ Unless, as Rivoira suggested, it was due to fear for the stability of the west wall, which receives no support from aisle vault or abutting arches in triforium (*Lombardic Architecture* [Eng. edn.], ii, 241), though this consideration did not deter the builders of the vault over the north transept a few years later.

the vaulting for which it had been planned; it must therefore have been due to restricted means—possibly indicated by the *modo remissius* of the chronicler. As the vault was eventually built (*modo intentius*), it is indeed unfortunate that financial limitations or uncertainty should have led to these hesitations and changes of design, with the result of an imperfect realization of the complete scheme of vaulting which was originally intended.

The date of the completion of the eastern arm is definitely fixed by the translation in August 1104 of the body of St. Cuthbert to the shrine at the east end of the new work. One of the earlier accounts of this great translation says that no small part of the church which had been founded by bishop William was finished, and the time was at hand for translating into it the venerable body of our father Cuthbert, so that it might be worthily honoured in the place which had been prepared for it by the industrious workmen.¹ We shall see that this completed choir included its original vault.

It is probable that the south transept was finished somewhere about the same time. The upper part of the north transept with its vault followed later, and these with the crossing arches were the latest works of what may be called the first principal building-campaign, which there is reason to believe was completed within the first decade of the twelfth century.

This first campaign included the commencement of the nave, which as usual was built to abut the crossing—here comprising two bays of the great arcades and aisles (13-17 a b, 14-18 a b), and one bay of the triforium stage (15, 17 a b; 16, 18 a b); nothing of the clearstory. In this earliest eastern part of the nave we notice that certain modifications were already introduced which affected the later continuation of the nave. The clear width of the nave itself is some 3 inches less² than that of the choir, but the aisles are each quite 2 feet wider than the choir aisles.

¹ 'Interea ecclesia, quam quondam Guillelmus episcopus fundaverat, non parva ex parte perfecta, venerabile patris Cuthberti corpus in hanc fuerat transferendum, et dignae venerationis gratia in loco, quem studiosa manus artificum adaptaverat, decenter recondendum' (*De Miraculis*, in

Symeon, i, 248). Mr. Arnold says that this chapter may well have been written by Symeon, though we cannot prove it. Cf. the passage in William of Malmesbury's *Gesta Pontificum* quoted below, p. 124, n. 1.

² The transept is about a foot wider than the choir.

The western bay of the choir is narrower than the three eastern bays, being governed by the width of the transept aisle, and the width of this narrower western bay was followed in setting out the three eastern bays of the nave.¹ Westward of these three bays (from piers 11 a and 12 a westward) the bay-width is increased by 2 ft. 1 in. to 2 ft. 3 ins. though this width is still about a foot less than that of the three eastern bays of the choir. It would seem therefore that the foundations of the piers 11 a and 12 a were built with the first section of the nave. There are some slight indications in the masonry of the aisle walls that these were built up to 11 b and 12 b as part of the first build, though only two bays of each aisle have the earlier vaults.

The minor piers of the great arcades of the choir and east side of the transept are large cylindrical piers built on bases 7 feet wide² (the standard thickness of wall), and they have triple attached shafts at the back to receive the aisle vaults. In the eastern double bay of the nave, the diameter of the minor piers (15 a and 16 a) is increased by one foot, and the triple shafts on the back are omitted, for the increased size of the pier gives a projection into the aisle which is sufficient to receive the springing of the vault. The surface decoration of these two cylindrical piers is of more advanced character than the spiral decoration of the cylindrical piers in the choir.³ On the aisle walls opposite these minor piers (at 15 b and 16 b), half-

¹ The width of the eastern bay of the nave (15, 17 a; 16, 18 a) is actually some 3 inches more than that of the western bay of the choir (measuring both from the centres of the crossing piers), and than that of the following bays of the nave (11-15 a, and 12-16 a). As the eastern bay of the nave is set out from the centre of the crossing pier, the clear width of this bay of the arcade is less than that of the two bays to the west of it.

² The piers themselves are about 6 inches less in diameter.

³ Surface decoration with spirals, etc. is not uncommon on small shafts in Romanesque architecture, but its application to great piers like these of Durham seems to have been an innovation, though it was followed in later works which were influenced by Durham. The spiral decoration of the two easternmost cylindrical piers in the choir (25 a, 26 a) is worked with a large

sunk bead or half-roll, and of the two westernmost (21 a, 22 a) with a large hollow. In the north transept, the decoration also consists of spirals, of a large hollow on pier 19 b, and a sunk bead on 19 d. In the south transept, the spiral of pier 20 b has a large hollow, while 20 d has a chevron of a large hollow with a kind of arrow-head in each point. In the nave, the two piers which belong to the first work (15 a and 16 a) have a lozenge pattern worked with two narrow v-shaped grooves, leaving blank squares at the intersections. The next pair (11 a and 12 a) have chevrons worked with a sunk bead between two fillets and hollows; these two piers have a narrow band of star ornament immediately below the neckings of the capitals. The remaining pair (7 a and 8 a) have vertical flutes and large beads separated by fillets. In all cases the decorations were worked on the stones before they were set.

round piers take the place of the triple shafts. These changes of plan of arcade piers and aisle piers are followed in the later work westward. The major piers which formed part of the first work (13 a and 14 a) are about one foot wider (from east to west) than the major piers of the later work (5 a, 6 a, 9 a, 10 a).

I have suggested that this first great building-campaign was finished before the end of the first decade of the twelfth century, with the completion of the upper part of the north transept. It seems to me to be most probable that the second campaign on the nave was only seriously begun after the north transept had been finished. Fortunately the general scheme of the earlier work was followed, with little more than modifications of detail—except in the preparation for vaulting which will be discussed presently.

The major piers 13 a and 14 a of the arcades are part of the first work, including the arcade capitals on the west side of the piers, but the arches which spring from them (11, 13 a; 12, 14 a) belong to the second work. The capitals of the arcade piers westward are rather less in height than the earlier capitals. In the inner order of the arcade arches, the soffit roll is flanked on each side by a hollow alone, instead of the roll and hollow of the earlier arches. The second orders are decorated with chevrons, of the type extensively used throughout this work, in which the chevrons are worked as it were around a convex (quasi-quarter-round) profile. On the nave side is an outer order of slight projection, which is decorated with a series of sunk squares above a small angle roll. The chevron appears in the ogives of the vaults of the aisles from 13 a b and 14 a b westward.

In the triforium stage the vaulting shafts were omitted, and the wall-face brought forward to the face of the arcade wall below,¹ with containing arches of two orders to the openings. On the south side of the nave, both the orders of the containing arch are decorated with chevrons of the type described above (plates 1; xi, 2). On the north side, the inner order only has chevron decoration of this type, and the outer order has an angle roll with plain

¹ How this modification was started in the eastern bay will be explained below.

chevrons sunk square in the flat face above (plates XI, 1; XII, 1, 2).

The whole of the clearstory stage belongs to the later build. Its construction and the change of form of the abutment arches over the triforium gallery will be dealt with below in connexion with the vaults.

This second campaign included the west front and the western towers up to the height of the top of the clearstory walls of the nave. The nave had been carried up *usque testudinem* at the time of Flambard's death in 1128, and it was completed by the monks before the accession of his successor in 1133. What this means precisely will be discussed in the sequel.

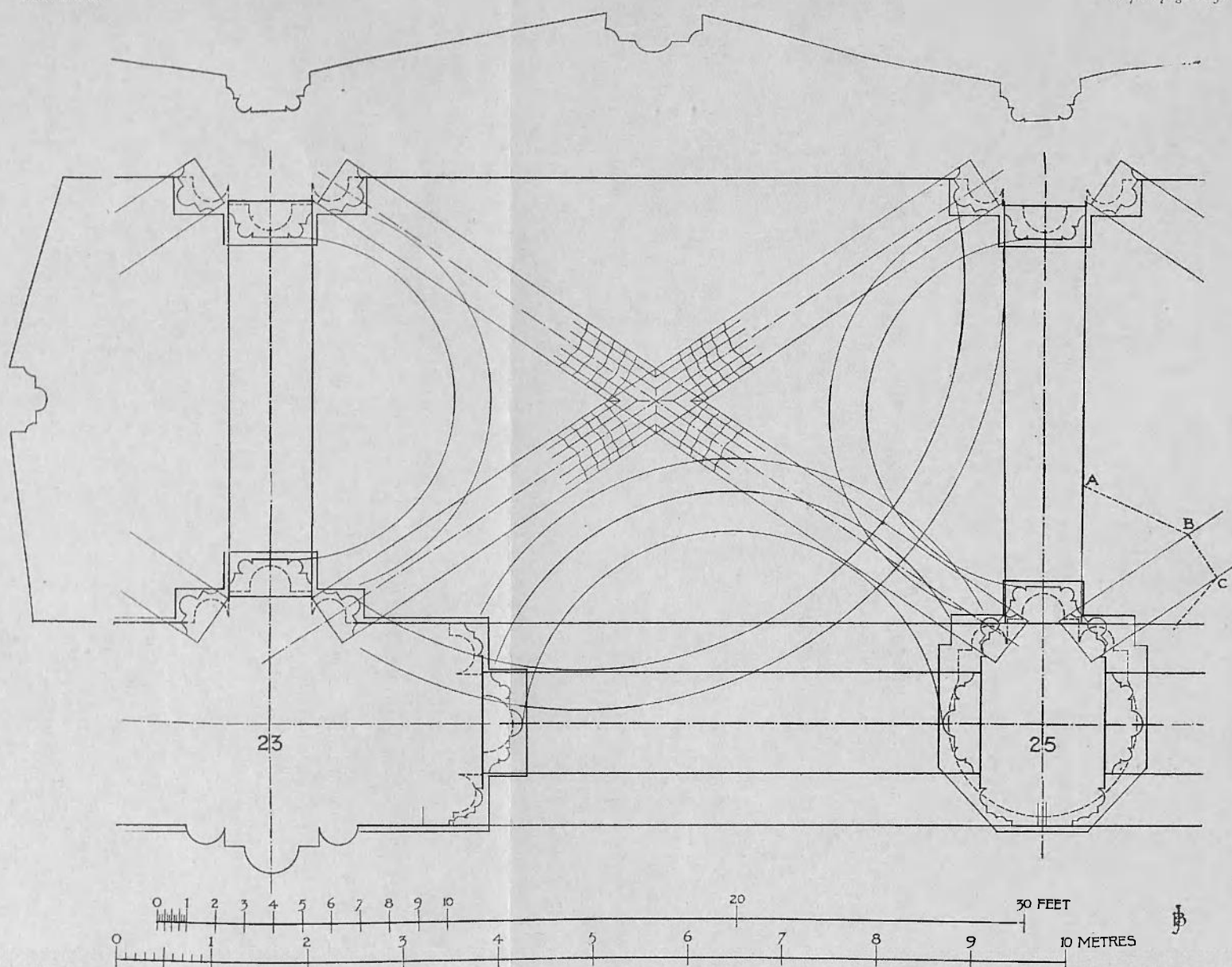
From the foregoing it will be seen that the general lines of the story of the building—apart from the vaults—are perfectly clear and certain, from the beginning from the east end in 1093 to the completion of the nave between 1128 and 1133. It may not be certain precisely how much had been built at any given date, but any difference of opinion can only affect the date of any particular part of the building by very few years. We have therefore a sure foundation to receive the evidence afforded by the structure itself as to the precise relation of the vaults to the walls, which will now be considered.

We will begin our survey of the vaults

AISLES OF
CHOIR AND
TRANSEPT

themselves with those of the aisles which formed part of the first principal building-campaign. These comprise the north and south aisles of the choir, the aisle on the east side of each arm of the transept, and the two eastern bays of the north and south aisles of the nave—eighteen bays in all. All these vaults are identical in method and detail. The modifications which were introduced in the plan of the supports in the eastern bays of the nave aisles have already been mentioned, and it will be convenient to postpone our consideration of the vaults of these bays until the vaults of the aisles of the choir and transept have been dealt with.

The plan of the choir and transept aisles shows that they were prepared for vaults from the first. Each of the major and minor piers of the main arcades is provided with



NORTH AISLE OF CHOIR, PLAN OF VAULT (23, 25 ab).

a group of three shafts¹ at the back, and the aisle walls opposite have similar triple shafts (plate II), with single shafts to the end walls and piers. Each member of the vault is therefore received by its own shaft, built with the walls and piers and forming part of the original construction. At the back of the minor piers the regular bonding of the triple shafts and their bases and plinths to the cylindrical piers and their bases and plinths proves that they are of the same build and not subsequent additions.

The vaults are ribbed vaults² of the earliest type,³ in which the curves of the doubleaux are semicircles, stilted to the narrower spans, and the ogives are segments of circles struck from centres below the springing line. The vaults of the various bays vary only with the different proportions of the plans of the bays. The greater width of the three easternmost bays of the choir (21-27, 22-28) gives the aisle vaults a much greater length (from east to west) than their width (from north to south). The western bays of the aisle vaults (19, 21 ab; 20, 22 ab), and those of the transept aisles (19, 21 b-e; 20, 22 b-e), though still slightly oblong, are much more nearly square.

The vault of one of the easternmost bays (23, 25 ab) is illustrated in detail by plate II,⁴ and the following description applies to this bay.⁵ The shafts at the back of the minor pier (25 a) project into the aisle about 1 foot less than those at the back of the major pier (23 a); the span of the doubleau 25 ab is therefore a little greater than that of the doubleau 23 ab; and, while the former is a semicircle, the latter is a semicircle stilted about 10 inches. Owing to the pronounced oblong plan of the bay, the span of the ogive is more than double that of the doubleaux. The key of the ogives is considerably higher than the crowns of the doubleaux, and all the cells of the vault slope upwards

¹ What I call 'shafts' (here and elsewhere) might perhaps be more precisely described as half-shafts, as they approximate to semicircles on plan, as usual in work of this period.

² I use the term 'ribbed vault' as meaning the groined vault with diagonal ribs (Fr. *croisée d'ogives*), confining the term 'groined vault' to the *voute d'arêtes* (without diagonal ribs). I also use the term 'doubleau' instead of 'transverse arch' or

'transverse rib,' and 'ogive' instead of 'diagonal rib.'

³ I have already sketched in this *Journal* the evolution of vault construction in the Norman Romanesque school (*Archaeol. Journal*, lxxiv, 3 ff.).

⁴ In the plans of vaults which illustrate this paper, the centre line of the doubleau or ogive on plan represents the springing line on which their curves are set up.

⁵ For the ground and triforium plans of this bay, see *Journ. R.I.B.A.* vi, 297, fig. 9.

toward it.¹ The segmental curves of the ogives are struck from centres about 4 feet 9 inches below the springing line, and the ogives consequently leave the capitals at a very abrupt angle.² The curves of the lunettes on the side walls are lower than semicircles. The lunette on the main wall is not concentric with the arcade arch, owing to the great width of the major pier, which causes a spandrel of wall to be left between the arch and the vault on the side next the major pier. Owing to the fact that the centres from which the ogives are struck are at a much lower level than the centres of the lunette curves on the side walls, the surfaces of the cells next the choir wall and aisle wall are very considerably twisted. The ribs, like the arches generally, are constructed of thin stones, averaging about 7 inches in thickness. The keys of the ogives are jointed in a primitive fashion; the sides of the keys are not shouldered for the ribs, but the joints continue the lines of the sides of the ribs, and stones of nearly triangular shape are introduced next the key to bring the next joint square with the rib (plate 11). The vaults have no wall-rib or wall-arch. The cells are built of rubble, and plastered.

The profiles of the arch mouldings of the choir arcades and aisles deserve attention. Of the series illustrated in fig. 2, the first to be built would be the wall-arcades beneath the aisle windows—the internal arcade of intersecting semicircular arches, and the external arcade of simple semicircular arches of two orders.³ The arches of the internal arcade are moulded with a quirked angle-roll below a hollow with a quirk beyond it (fig. 2, i). This profile is found at Saint-Étienne, Caen, in the arches of the doorways of the west front, which date from about 1080, and it occurs a few years later in the arches of the lower windows of the apse of Saint-Nicolas, Caen. At Lincoln it is found in the arches of the recesses of the west front, which may date from about 1090, and it occurs in the ground-story arcade of the apse of Norwich, begun in 1096. In the arches of the external arcade here, the inner

¹ The sections of the vault at the crown are shown in plate 11. In this bay the surface of the vault cells at the key of the ogive is about 8 inches above the crown of the lunette on the main wall (over the great arcade), 1 foot 9 inches above the crown of the

lunette on the aisle wall, and 2 feet 3 inches above the crowns of the doubleaux.

² These characteristics are of course less pronounced in the bays which are more nearly square.

³ *Billings*, pl. 6, 9, 11.

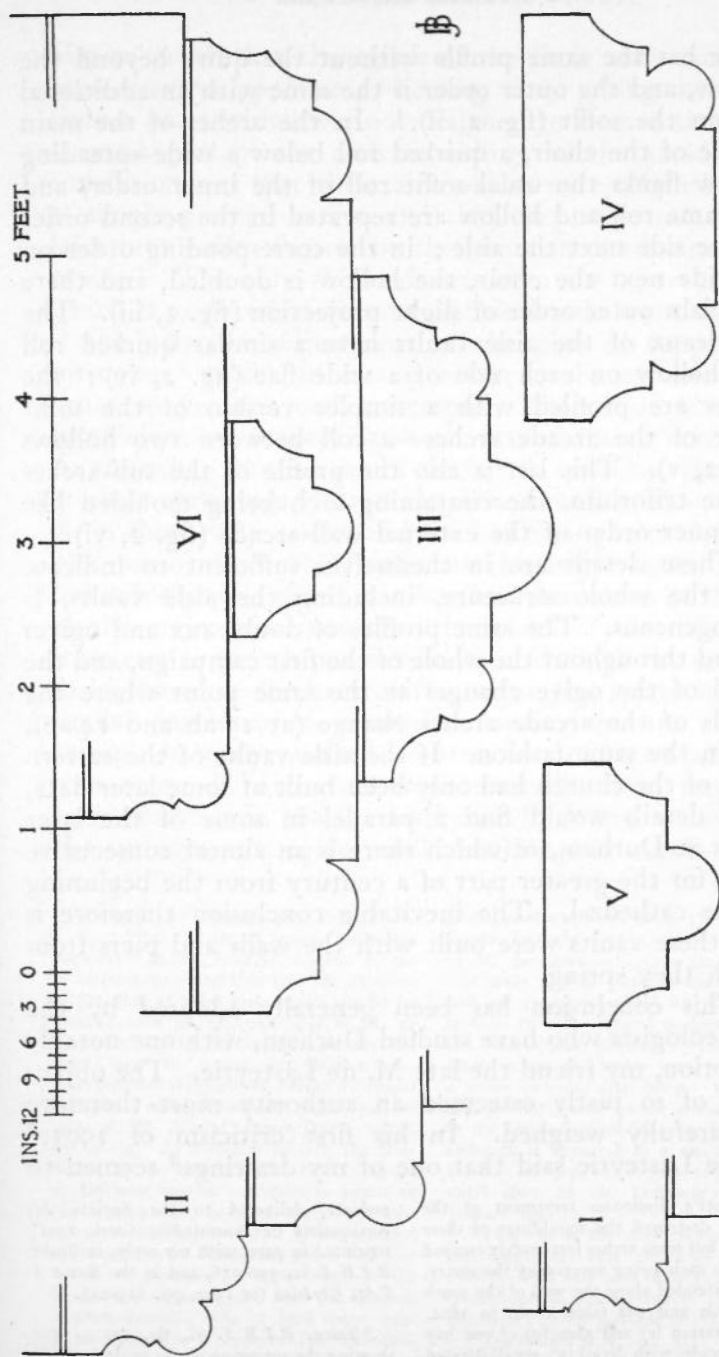


FIG. 2. DETAILS OF CHOIR AND AISLES.

Arches of aisle wall-arcades: I, internal; II, external. III, Choir arcade arch. Aisle vault: IV, doubleau; V, ogive. VI, Triforium arch.

order has the same profile without the quirk beyond the hollow, and the outer order is the same with an additional roll on the soffit (fig. 2, ii).¹ In the arches of the main arcade of the choir, a quirked roll below a wide-spreading hollow flanks the usual soffit roll of the inner order, and the same roll and hollow are repeated in the second order on the side next the aisle; in the corresponding order on the side next the choir, the hollow is doubled, and there is a plain outer order of slight projection (fig. 2, iii). The doubleaux of the aisle vaults have a similar quirked roll and hollow on each side of a wide flat (fig. 2, iv); the ogives are profiled with a simpler version of the soffit order of the arcade arches—a roll between two hollows (fig. 2, v). This last is also the profile of the sub-arches of the triforium, the containing arch being moulded like the inner order of the external wall-arcade (fig. 2, vi).

These details are in themselves sufficient to indicate that the whole structure, including the aisle vaults, is homogeneous. The same profiles of doubleaux and ogives extend throughout the whole of the first campaign, and the detail of the ogive changes at the same point where the details of the arcade arches change (at 13 ab and 14 ab), and in the same fashion. If the aisle vaults of the eastern parts of the church had only been built at some later date, their details would find a parallel in some of the later works at Durham, of which there is an almost consecutive series for the greater part of a century from the beginning of the cathedral. The inevitable conclusion therefore is that these vaults were built with the walls and piers from which they spring.

This conclusion has been generally adopted by the archaeologists who have studied Durham, with one notable exception, my friend the late M. de Lasteyrie. The objections of so justly esteemed an authority must therefore be carefully weighed. In his first criticism of 1901,² M. de Lasteyrie said that one of my drawings³ seemed to

¹ Wyatt's disastrous treatment of the exterior destroyed the mouldings of these arcades, but some arches fortunately escaped owing to their being covered by the vestry, which extended along the wall of the south choir aisle and was taken down in 1802. The elevation (F) and plan (G) of one bay of the arcade, with detail (X), are illustrated in *Billings*, pl. 59.

² *Discours sur les origines de l'architecture*

gotique, delivered to the Société des Antiquaires de Normandie (Caen, 1901), reprinted in part, with my reply, in *Journ. R.I.B.A.* ix, 350-356, and in the *Revue de l'Art Chrétien* for 1902, pp. 213-223.

³ *Journ. R.I.B.A.* vi, fig. 12, p. 300, showing the springing of the vault from the minor pier 25 a—shown also here in the photograph plate III, 1.

him to prove that the ogives of the choir aisle vaults had been *ajoutées après coup*, because they spring awkwardly from a place which was not designed to receive them, and so mask part of the arch mouldings of the arcade. His conclusion was that these aisle vaults were originally built as simple groined vaults, and that they were transformed later into *voutes d'ogives* by the insertion of ribs under the groins.¹ The only reason drawn from the structure itself which is adduced in support of this drastic transformation is the defective adjustment of the plan of support and springing,² which in fact is rather to be expected than otherwise in such early attempts. The reason is entirely insufficient to support such an extraordinary conclusion. At the other three angles of the bay in question, the ogives at their springings clear themselves as well as they usually do in these early vaults, and the bad fitting over the minor pier results from the facts that the triple shafts project towards the aisle about one foot less than those at the back of the major pier, and that the width of the minor pier from east to west is not sufficient to admit of the complete springing as at the back of the major pier (plate 11). But similar instances of incomplete springings are common enough in early vaulted construction of more advanced character; I have cited some examples from important early churches in the Ile-de-France.³ When we find that the springings of ogives mask mouldings of arcade arches,

¹ *Journal des Savants* for Feb. 1908, p. 63. I have dealt at length with this impossible theory, because it seems to me to be eminently desirable that the question of the date of these aisle vaults should be decided once for all, especially as M. de Lasteyrie's views are repeated in his last work now in course of publication—*L'architecture religieuse en France à l'époque gothique : ouvrage posthume publié par les soins de M. Marcel Aubert* (Paris, 1925), pp. 28–34. As a matter of fact, the time which M. de Lasteyrie was able to spend at Durham was far too short to admit of his making that detailed analysis of the structure which is essential to the solution of its problems. His former pupil, and successor as professor of archaeology at the Ecole des Chartes, the late M. Eugene Lefevre-Pontalis, who in 1908 spent some hours daily for a week in the cathedral, arrived at very different conclusions

(*Bulletin Monumental*, lxxii, 371; *Archaeological Journal*, lxxv, 315). My criticism of M. de Lasteyrie's views on this question must not be taken as indicating any lack of appreciation of his pre-eminent services to architectural archaeology; on the contrary, our difference with regard to Durham had the happy result, for me, of a warm personal friendship. I ought to add that my article on the general question in the *Archaeological Journal*, lxxiv, 1–35, although it appeared in a volume bearing the date of 1917, was not actually published until after M. de Lasteyrie's death in January 1921.

² This too is the only reason given for the suggestion that the aisle vaults of Peterborough may have undergone a similar transformation (*L'architecture religieuse en France à l'époque gothique*, p. 32).

³ *Journ. R.I.B.A.* ix, 352. *Revue de l'Art Chrétien* for 1902, p. 220.

half a century later, in such accomplished work as the choir aisles of Laon cathedral, and much later still at Saint-Yved de Braine,¹ we need not be surprised to find these incomplete springings in such primitive work as Durham. If these aisle vaults were originally built as *voutes d'arêtes*, the triple shafts must have been designed to receive the projecting groins.² But this does not get rid of the difficulty of the bad fitting over the minor pier which is the sole reason for the assumed addition of ogives, for an examination of the springing plan on pier 25 a (plate II) will show that there would be no room for such a projecting groin between the arcade arch and the doubleau of the vault. Moreover while the triple shafts on the piers and aisle walls might conceivably be so interpreted, there is one group of shafts (on each side) to which this explanation cannot possibly apply—those at the angles between the choir aisles and transept aisles (21 b, 22 b), illustrated by plate III, 2. These shafts were built with the walls as part of the original construction. Facing the choir aisle there are the usual three shafts, one of which receives the ogive of the angle bay. Facing the transept aisle there are only two shafts, for the ogive of the angle bay was already provided for.³ Such a plan can only have been designed to receive the actual vaults.

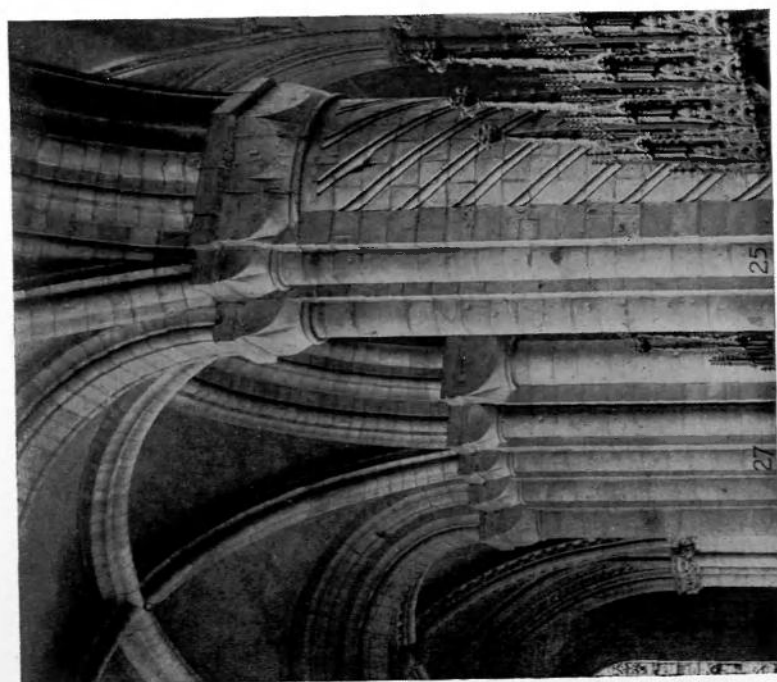
The extent of the suggested transformation of these aisle vaults must be noted. It must include all the aisles which formed part of the first campaign (all to the east of 13, 14). But this is not all. If the vaults of the nave aisles (from 13, 14 westward) are original, they must have been built during the second decade of the twelfth century. This however is too early for M. de Lasteyrie's theory, which postulates that the ogives of Durham are not earlier than those of Saint-Denis.⁴ The nave aisles must also therefore have been covered originally with simple groined vaults, to which ogives must have been added at some

¹ Choir pier east of crossing. Cf. volume of the *Congrès archéologique de Reims*, 1911, i, 431, and fig. Both at Laon and Braine the reason is the same; the abacus of the cylindrical pier did not afford sufficient space for a complete springing.

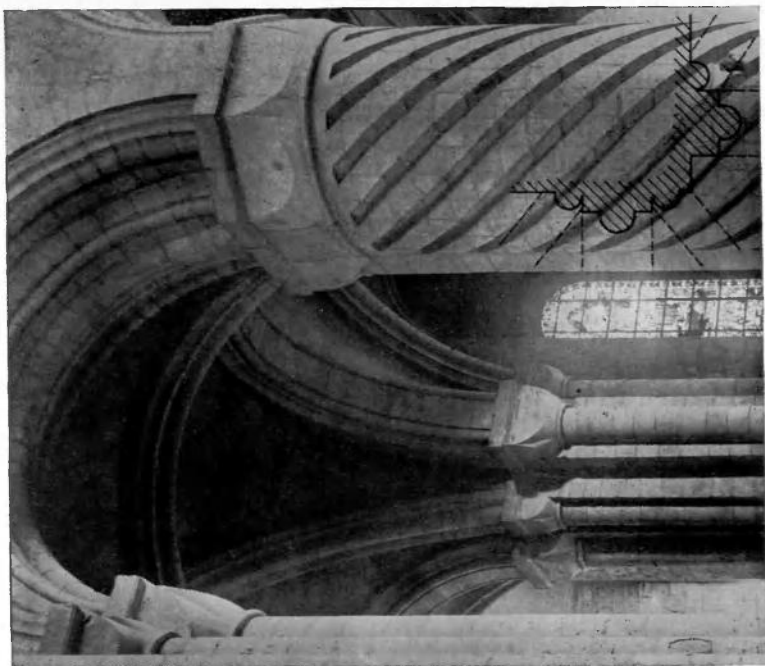
² As at Saint-Étienne, Caen, Winchester, Ely, etc. (*Journ. R.I.B.A.* vi, 293, and figs. 2 and 4).

³ The plan of the shafts at 22 b is drawn over the photograph reproduced in plate III, 2.

⁴ *L'architecture religieuse à l'époque romane*, 497 n. Cf. *L'architecture religieuse à l'époque gothique*, 34:—'il n'est même pas certain qu'elle' (la croisée d'ogives) 'ait fait son apparition en Angleterre fort longtemps avant 1140.'



[J. R. Edis, photo.
I. NORTH CHOIR AISLE VAULT (25, 27).



[J. R. Edis, photo.
2. ANGLE OF AISLES OF CHOIR AND SOUTH TRANSEPT (22 b).

unspecified later date. The suggested transformation must therefore include all the aisle vaults from end to end of the cathedral, thirty bays in all. Moreover in adding the ogives the builders must have adopted a method which was strangely alien to mediaeval practice; where the arcade arches were simply moulded, the ogives were given a simple moulded profile; when they came to the point where chevron ornament had been introduced in the arcade arches of the original build of the nave, the added ogives were ornamented with chevrons of precisely the same type as those in the original arches, and not of the type of which examples exist at Durham in works built after the completion of the nave.

The theory, very improbable in itself, could only be entertained if the vaults themselves showed indications that the ogives had been added. No such indications exist. On the contrary, the construction of the vaults proves conclusively that the theory is untenable. The groin of an unribbed vault is a semi-ellipse, but the actual curve of the ogive is a segment of a circle. If the ogives had been added, they must have been backed out to the elliptical curve of the groin, but this is not the case. In his later criticism¹ M. de Lasteyrie passed lightly over this point as a merely theoretical objection, expressed his belief that groined vaults were often reinforced later by the addition of ogives,² and cited an example at Winchester which I had mentioned. This example is material, because it shows what we might expect to find at Durham if the suggested addition had in fact been made.

The aisles of the transept of Winchester cathedral³ were originally covered with simple groined vaults, several bays of which remain unaltered.⁴ The altered bays show two kinds of ribbed vaults: (1) vaults which were entirely rebuilt as such in the course of the reconstruction which followed the fall of the central tower in 1107; and (2) original groined vaults with ogives added later under the groins (the addition suggested for Durham). In the former

¹ *Journal des Savants* for Feb. 1908, p. 63. Cf. *L'architecture religieuse à l'époque gothique*, 32.

² In the Anglo-Norman school, examples are extremely rare.

³ Church begun in 1079; entered by the monks in 1093.

⁴ *The Aisle Vaulting of Winchester Transept*, by Professor Charles H. Moore, *Journ. R.I.B.A.* xxiii, 317, 329; by John Bilson, *ibid.* xxiv, 65.

we find the same clean fitting of the cells to the backs of the ogives as at Durham.¹ In the latter the ogives are backed up to the surface of the original vaults, and show quite clearly that they are additions.² Nothing of the kind is to be seen at Durham.

Even if we ignore the very real difficulty of difference of curve, which is much more than a merely theoretical difficulty, it would only have been possible to avoid backing up the ogives by cutting away the groins in order to fit the angles A and B of the backs of the ribs close up to the

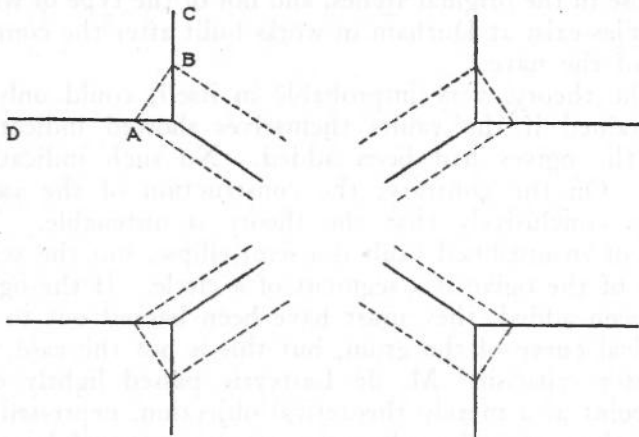


FIG. 3.

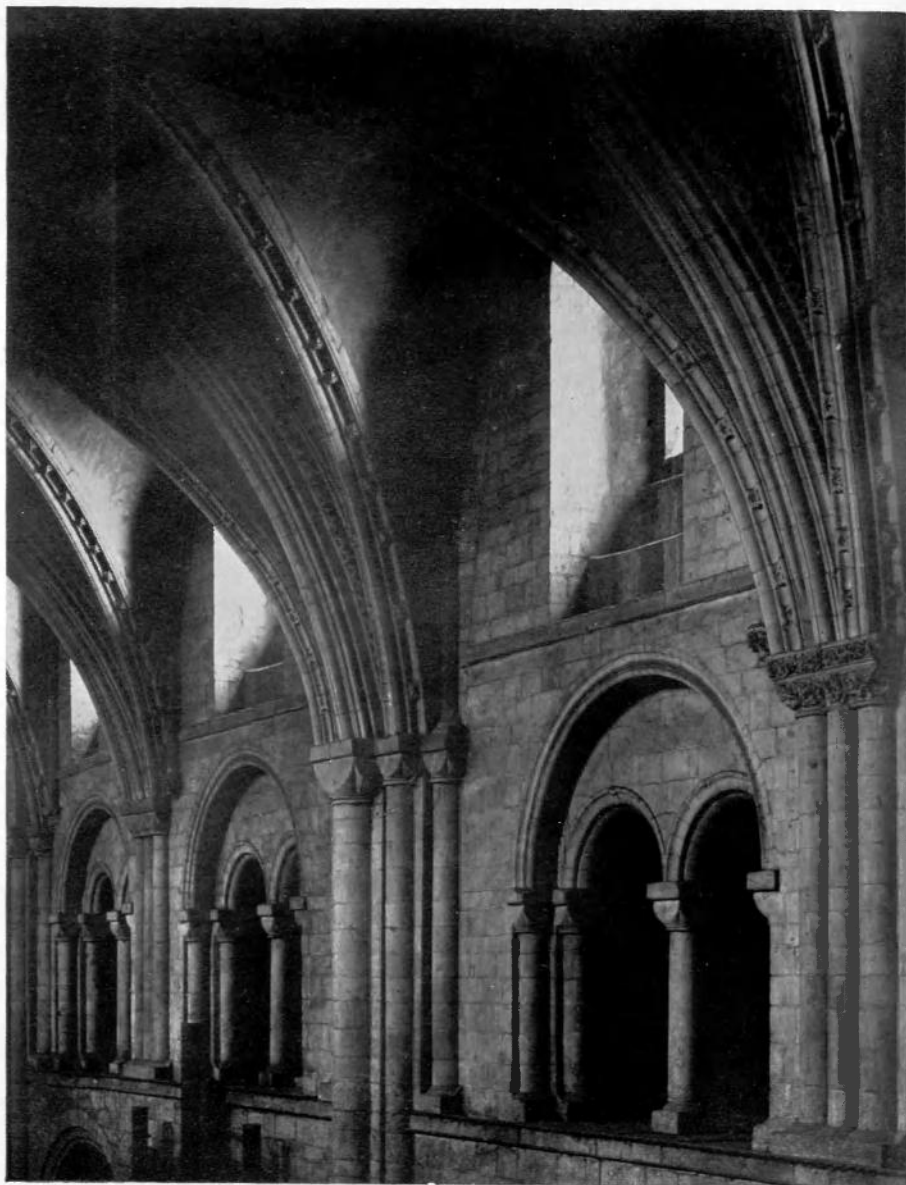
surfaces of the vault AD and BC (fig. 3). In the eastern bays of the choir aisles, which are markedly oblong on plan, such an operation would involve placing the ogive out of the centre of the groin, in order that its two back angles A and B might coincide with the vault surfaces AD and BC; and this shifting sideways out of the centre of the groin must have been in one direction for one half of the ogive, and in the other direction for the other half,³ which would

¹ Cf. fig 2, *ibid.* xxiv, 67, with plate III, 1, above.

² Two of these vaults are minutely described and illustrated in Professor Moore's paper (pp. 317, 329). He writes: 'That these are the primitive vaults with the ribs added later is shown by the surfaces, which are not shaped to the ribs as they would be if both were contemporaneous parts of one whole, but have the same conformation as the ribless vault that we have just examined.

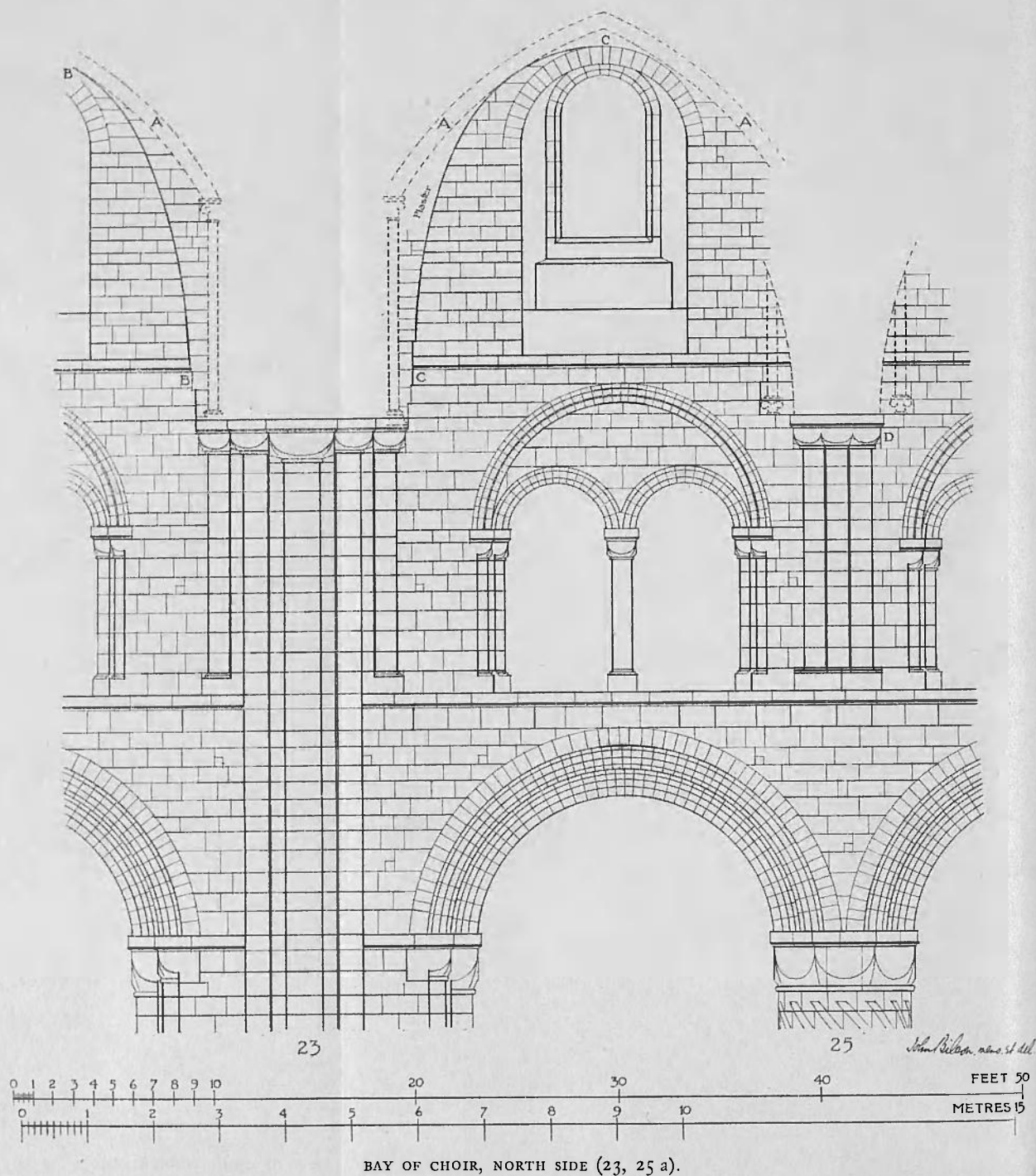
The groins of these vaults have, of course, elliptical curves in elevation, but the curves of the ribs are arcs of circles, and thus do not fit the groins. They have therefore to be backed up with masonry to fill the intervals between the two curves.'

³ Assuming that the groin lay in one vertical plane, represented by a straight line on plan. In oblong vaults, this line is generally curved, which would make the suggested addition still more impossible.



[E. Lefèvre-Pontalis, photo.]

CHOIR, NORTH SIDE (19, 21, 23, 25 a).



have resulted in one half of each ogive being about 8 inches out of line with the other half.

The final proof that the suggested addition has never been made is afforded by the conformation of the cells. The surfaces of the simple groined vault are more or less cylindrical. The cells of these aisle vaults are not, but their surfaces are determined by the curves of the doubleaux, ogives, and lunettes—by the fact that they were built on straight centering between the two bounding curves. The low curve of the ogive necessitates a pronounced twisting, or ploughsharing, of the surfaces of the cells next the side walls, which is especially noticeable in the oblong eastern bays of the choir aisles. On plate II I have shown, on the east side of the pier 25 a, by the dotted lines AB, CD, the horizontal section of the vault at a height of 7 feet above the springing line. Such conformation of surface is absolutely impossible for the simple groined vault. We may therefore regard it as definitely proved that all these aisle vaults formed part of the original work, and were built with the walls and piers from which they spring.

The vaults of the two easternmost bays of the aisles of the nave (13-17 ab, 14-18 ab) are precisely the same as those of the aisles of the choir and transept, except for the slight modification resulting from the altered form of the minor piers already noticed. For the cylindrical pier with attached shafts at the back to receive the aisle vaults of the choir and transept, a cylindrical pier of increased diameter without attached shafts was substituted—a less logical form of support, which however had the advantage of enabling the ribs to clear themselves much better at their springing. As in the choir and transept, the projection of the minor pier into the aisle is less than that of the shafts on the back of the major pier; the span of the doubleau opposite the minor pier is consequently wider than that of the doubleau opposite the major pier, and their curves are adjusted accordingly.

CHOIR

The choir of Durham deserves more consideration than it has generally received, for it is here that we can realize the admirable conception of the first master, of a completely vaulted structure with supports logically designed to receive the members of the

high vault, and with provision for the abutment of its thrust; and here the structure was carried to completion without alteration. The high vault failed, and had to be rebuilt in the thirteenth century. In the nave, which generally receives more attention, the vault has survived, but the modifications of the original scheme which were introduced in the transept and nave involved an unfortunate weakening of the logical expression which is such a marked characteristic of the choir.

The great translation of 1104 marked the completion of the choir, which included the high vault. The recorded evidences furnish two references to the high vaults of the eastern arm. One is contained in a wonderful story related by William of Malmesbury in connexion with the translation—how St. Cuthbert himself in the night removed the centering which supported the vault above the shrine.¹ As the shrine stood within the apse, it may be held that this passage only proves a stone vault to the apse itself, but if the apse were vaulted the probability is that the whole eastern arm would also be vaulted, and we shall see that there is definite proof that it was. The other reference is contained in an indulgence of 1235,² which proves that the vault over the eastern part, expressly described as a *stone* vault, was then threatening ruin.

In the choir (as in the transept and nave) the group of three shafts³ on the face of the major piers rises from the floor to the same height as the shafts of the crossing piers (plates iv and v, and fig. 4),⁴ and was obviously intended

¹ 'Ad translationem corporis parata erant omnia in nova ecclesia; chorus monachorum, altare, sepulchrum. Expectabatur tantum ut materia lignorum, quae recentem presbyterii testudinem sustinebat, leniter deponeretur. Sed non passus es, beatissime! sanctum tuorum desiderium prolongari, et omnia nocte intempestas ubruisti. Quis enim alius tanti facti auctor? Accurrit prior sono excitus, altari et pavimento timens. De lignis cura minor. Sed tu non solum illa quibus metuebatur, sed et ligna ita servaveras integra ut fuerant apposita. Merito ergo a monachis tuis timeris, ut nullus rebellionis contra priorem, vel in se gravis criminis conscius pernoscere audeat, delicti sine confessione reus.'—*De Gestis Pontificum*, ed. Hamilton (Rolls Series, 52), 275.

² 'Ubi supra sacrum illius sepulchrum devocio veterum lapideas erexit testudines, quae jam nunc plenae fissuris et rimis, dissolutionem sui indicant imminere.' Indulgence of Hugh of Northwold, bishop of Ely; Durham Treasury, Misc. Chart. no. 1512 (printed in Raine's *Saint Cuthbert*, appendix, p. 7; and in *Rites of Durham*, ed. J. T. Fowler (Surtees Soc. 107), 149). For other indulgences, see Raine, pp. 101-3, and *Rites*, 148-158.

³ The nave of Old St. Paul's, London, had a similar group of three shafts on the face of each pier, rising from the floor through the triforium stage: see pl. xli (after Hollar) in Dugdale's *History of St. Paul's Cathedral*, ed. Ellis.

⁴ On plate v and fig. 4 the existing vault of the choir, which was erected in the

to receive a great arch across the main span, repeating the motive of the crossing arches; and this strong membering of the alternate divisions contributes greatly to the powerful expression of the interior of the church.

The internal wall-face of the main wall of the triforium is set back 11 inches behind the wall-face below,¹ and on this set-off stand the vaulting shafts²—single shafts next the major piers, and triple shafts in the centre of each bay over the minor piers, with their capitals at the same height as those of the shafts on the major piers which rise from the floor (plates iv and v, and fig. 4). The triforium arcade is of a very usual type—two sub-arches within a single containing arch, all semicircular and moulded (fig. 2, vi), springing from two attached shafts on each jamb and a central monolithic shaft. The proportions of the arcade, wide and low in the eastern bay, are gradually improved in each bay from east to west.³

The transverse section of the choir (fig. 4) shows how the vault was abutted by semicircular arches beneath the roof of the triforium story⁴ (plate vi, 1). The outer wall is reinforced by broad pilasters, and at the back of the main wall are similar pilasters, of single projection behind the minor piers and double behind the major

middle of the thirteenth century, is omitted. The springing of the thirteenth-century vault, its wall-ribs (A, A, A), and the shafts which receive them are indicated by dotted lines on plate v. The capitals of the triple vaulting shafts at D (plate v) at 25 and 26 A, and those of the single shafts at 27 and 28 A were carved in the thirteenth century when the existing vault was built, but all the other vaulting shafts retain their original cushion capitals unaltered. The windows of the north aisle are later insertions; that shown by dotted lines on the section at F (fig. 4) is supplied from the transept aisle.

¹ This still leaves a wall of 6 feet in thickness, exclusive of the pilaster projections.

² It does not seem to have been noticed that in the nave of Gloucester the wall-face of the triforium is set back in the same fashion for vaulting shafts of which obvious indications remain on each side of the thirteenth-century vaulting shafts. There is definite proof that this nave was originally vaulted, not wood-ceiled as generally supposed.

³ The low proportion of the arcade in the

easternmost bay (25, 27) may possibly result from continuing the jamb-height of an arcade in the destroyed eastern bay (27, 29) or apse, where the bay-widths were less. The width of the opening is reduced a little in each successive bay, the width in bay 19, 21 being about 3 feet less than in bay 25, 27. The height of the jamb is increased by a few inches in each bay, the height in bay 19, 21 being about 17 inches more than in bay 25, 27. The height reached in bay 19, 21 is continued practically unaltered in the inner bays of each arm of the transept (19 ab; 20 ab) and throughout the nave. In the other three bays of each arm of the transept, which are narrower, the jamb-height is further increased. The height of the triforium stage of the choir (from triforium string to clearstory string) is in the transept increased by nearly 2 feet, at the expense of the clearstory. The increased height of the triforium stage is continued throughout the nave.

⁴ Cf. the similar semicircular abutting arches, the springings of which remain, in the nearly contemporary triforium of the choir of Chichester.

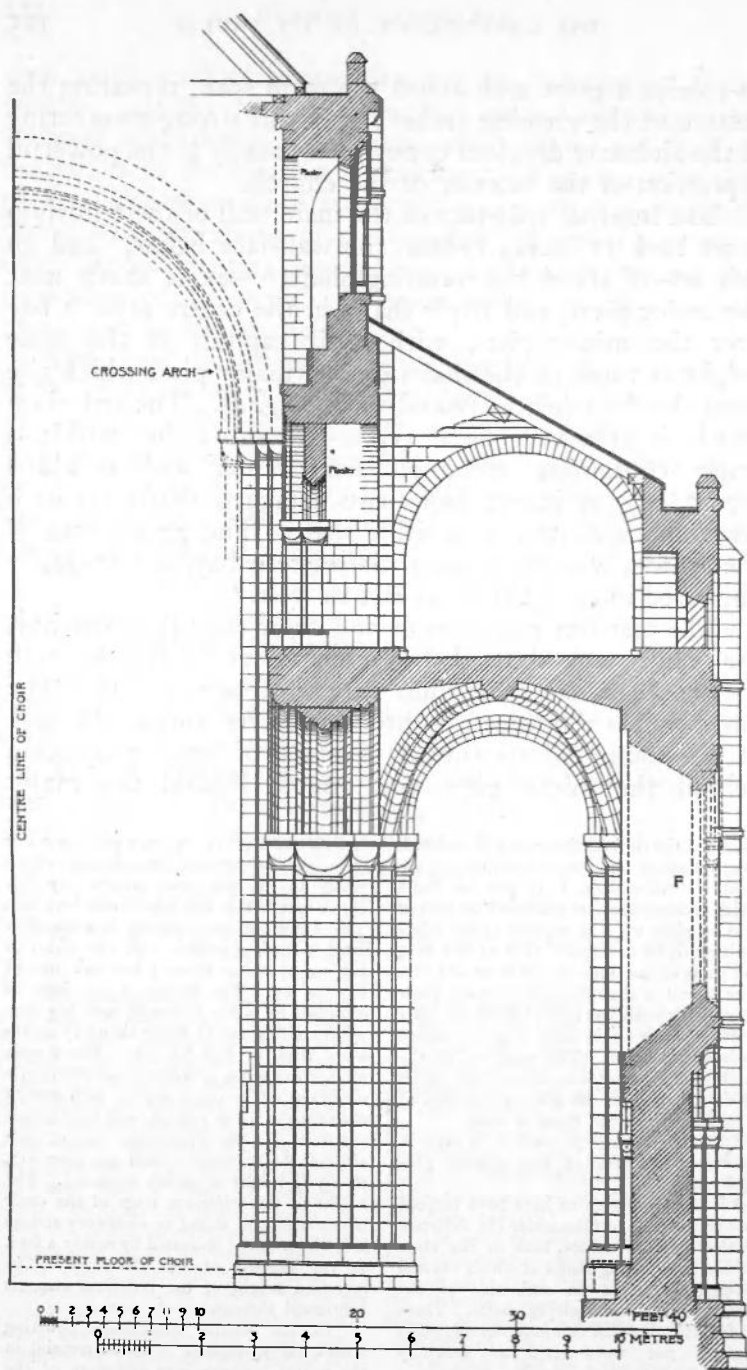
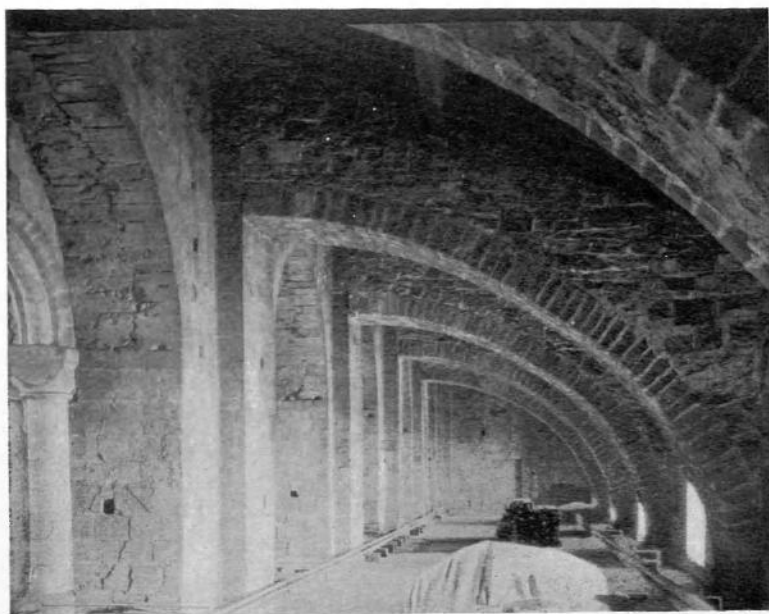


FIG. 4. HALF CROSS-SECTION OF CHOIR, NORTH SIDE.



[J. V. Saunders, photo.]

1. CHOIR TRIFORIUM, SOUTH.



[J. V. Saunders, photo.]

2. NAVE TRIFORIUM, SOUTH.

piers.¹ From these spring the abutting arches, 5 feet in width behind the minor piers, and 6 ft. 1½ ins. wide behind the major pier (23).² The pilasters form part of the original build, for their bed-joints generally range with those of the outer and main walls respectively, and their masonry is regularly bonded to these walls. The spandrels above the arch next the main walls are bonded at the internal angles, and the bed-joints generally range (fig. 4), which proves that the arches were built as the walls were carried up, and were not subsequent additions. The form of the arch is not well adapted to counteract the thrust of the vault, and, in spite of the great thickness of the walls, the arches have actually undergone some distortion.

The clearstories of the choir are treated more simply than those of the other parts of the church. Internally the windows have perfectly plain jambs and semicircular arch; externally shafted jambs with cushion capitals receive a semicircular arch of one moulded order, with double-chamfered hoodmould. There is no wall-passage,³ doubtless because the builders wished to avoid weakening the wall. On the external face of the clearstory there are pilaster buttresses only opposite the major piers—none opposite the minor piers.⁴

With regard to the relation of the clearstory to the vault, we notice first that the capitals of the vaulting shafts were built with the walls, for the three bed-joints of capital and abacus range with those of the walling (plate v), which proves that these shafts were never carried higher. The lines of the vault which they received are distinctly marked by the junction of the original masonry of the clearstory with the masonry which was added in the thirteenth century when the original vault was taken down and the existing vault built. The joint BB, CC (plate v) is visible on each side of the major piers (23, 24) and on the west side of the easternmost piers (27, 28), and

¹ For plan of the triforium, see *Journ. R.I.B.A.* vi, 297, fig. 9.

² These and other measurements and notes from the choir and nave which follow are taken from the north side, but they may be taken as applying generally to the south side also.

³ *Billings* (p. 28) says that the choir

clearstory originally had a wall-passage, and that it 'was built up to give solidity to the wall when the groining' (thirteenth-century) 'was constructed.' I think this is a mistake, for the idea seems to me to be contradicted by the masonry of the window jambs, and the stepped sills of the windows.

⁴ *Billings*, pls. 6 and 9.

shows that the curve of the lunette was a tall semi-ellipse, as in the vault of the north transept, the middle of the curve coinciding with the extrados of the window arch. We notice next the position of the clearstory windows in relation to the triforium arcades below. If there had been no question of a vault, the obvious plan would have been to place the clearstory windows centrally over the triforium arcades, but this is not the case in any one of the four bays, and the vault furnishes the reason why. The lunette of the vault was of course conditioned by the position of the vaulting shafts, and the triforium arcade is in no case central between the shafts. The difference is slight in bay 25, 27 a; rather more in bay 19, 21 a; and from 13 to 15 inches in bays 21, 23 a and 23, 25 a. In every case the centre of the clearstory window is moved out of centre of the triforium in the direction of the centre between the vaulting shafts; i.e. nearly to the centre of the lunette of the vault, as can clearly be seen in plate v. The position of the clearstory windows was therefore fixed by the vault, and this proves that the clearstory and the vault were built together. The vault therefore was built before the translation of 1104.

There is of course no definite evidence to prove exactly what this original vault was. The semi-elliptical lunette is characteristic of the simple groined vault,¹ as of the ribbed vault which superseded it. But while examples exist in Norman Romanesque churches of aisles covered with groined vaults, and the main spans with ribbed vaults, I know of no instance of the reverse. Indeed it is in the highest degree unlikely that the builders who had already constructed ribbed vaults over the choir aisles would return to the unribbed vault for covering the main span. I think we may therefore take it as practically certain that the vault of the choir which was finished in 1104 was a ribbed vault, and we may infer that it was probably like that which was built a little later over the north transept.

SOUTH
TRANSEPT
(1)

The east side of each arm of the transept, up to the top of the triforium stage,² continues the design of the choir, with the same complete preparation for a high vault. The face of the triforium wall is set back to receive the vaulting shafts as

¹ *Archaeological Journal*, lxxiv, 6.

² *Billings*, pl. 15.

in the choir, with the difference that the shafts over the minor piers are double instead of triple.¹ The semi-circular abutting arches beneath the triforium roof are the same, and show the same proofs that they are part of the original construction and were built as the walls were carried up. The motive of the triforium arcade is the same, with its proportions modified to suit the narrower middle bays² (19 bcd ; 20 bcd), while in the still narrower end bays (19 de ; 20 de) the opening is single, not subdivided into two as in the other bays. So far the two arms of the transept are alike. Then in the south transept the idea of a high vault was abandoned, and the clearstory was built to receive a flat wooden ceiling.

Externally the clearstory on the east side of the south transept has a pilaster buttress only opposite the major pier,³ as in the choir, and the windows follow the simple treatment of those of the choir clearstory, but with an arch of two orders.⁴ Internally the openings in front of the windows are perfectly plain, semicircular arched, and, except in the narrow southern bay (20 de), they are flanked by tall narrow openings with semicircular arches springing from the same level as the window arches (fig. 5).⁵ These narrow openings are partly masked by the later vault, and, when this was added, all the openings were walled up⁶ except the one on the south side of the window in bay 20 cd,⁷ which remains open. This arcade opens on to a tall wall-passage (see section on fig. 5), which is covered

¹ The double shaft is a more logical support for the two ogives of the vault of the north transept, or of the vault which was eventually built over the south transept, than the triple shaft of the choir, which very probably received the ogives of a similar vault.

² The width of the bays next the crossing (19 ab ; 20 ab) was determined by the width of the choir aisles. The length of the transept may possibly have been limited to suit the eastern range of the buildings around the cloister, some part of which had been built before the church was begun. However this may be, the length necessitated narrower bays than those next the crossing. These three bays (19 bcde ; 20 bcde) seem to have been divided nearly equally to the centres of the piers and the centre of the gable walls.

³ So also on the west side of the south

transept, and on both sides of the north transept (*Billings*, pls. 13, 16).

⁴ The clearstory windows have been extensively renewed, but it is unlikely that their general features have been altered.

⁵ The outline elevations of the clearstories on the east side of the south transept (fig. 5) and of the north transept (fig. 6) are drawn from actual measurement, and are complete except that the jointing of the masonry is not shown. On fig. 5 the existing capitals, vault lunettes, etc., are indicated by strong lines, and the pre-vault state by dotted lines.

⁶ The blocked openings are indicated by lighter hatching on the plan in fig. 5.

⁷ *Billings*, pl. 15, only shows this one opening, though the others exist as shown on fig. 5, except that the jambs indicated by dotted lines were removed when sections of the wall behind the springings of the vault were rebuilt.

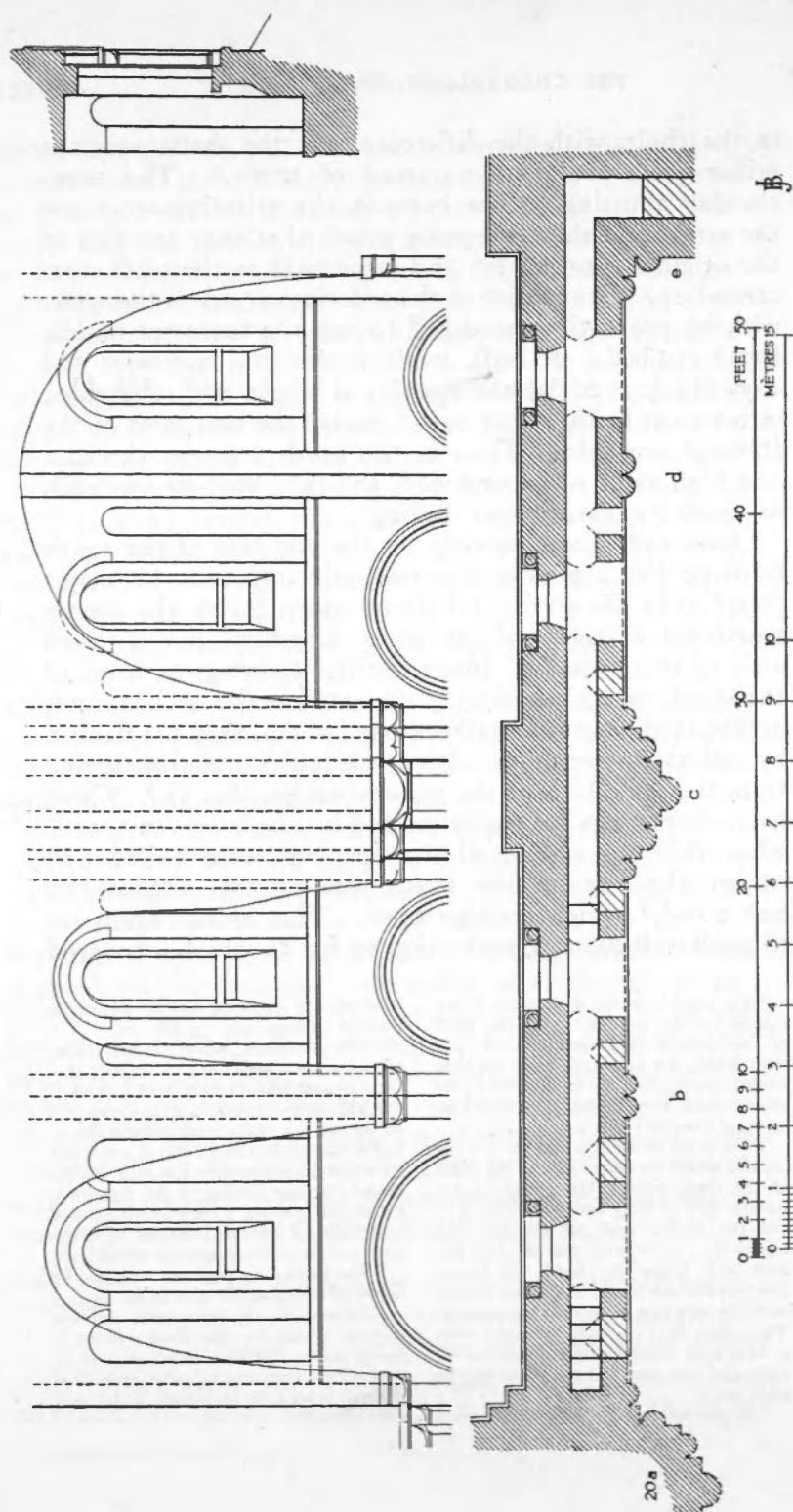


FIG. 5. SOUTH TRANSEPT, EAST CLEARSTORY.

with a little barrel-vault of plastered rubble (as are the other wall-passages in the church). The height of this wall-passage, about 11 feet from floor to crown of its vault, should be noticed, in contrast with the heights of the passages where the clearstories were built to receive high vaults. It is clear that, when the idea of vaulting was abandoned, the wall-shafts at 20 a, b, and c were carried up with the clearstory to the wall-head, as indicated by dotted lines on fig. 5. This is proved by the fact that the clearstory arcade is regularly spaced between the upward continuation of the existing shafts, which thus governed the setting-out of the arcade. The double shafts at 20 d were so carried up, and still remain, as they were not interfered with by the later vault.

The west side of the south transept¹ has the great triple shafts (at 18 c) as on the east side (at 20 c), but the width between them and the south end (18 ce) is treated as a single bay from the ground story upward. Indeed the considerable projection of the staircase in the south-west angle did not leave sufficient width for two bays as on the east side. The different character of the triforium openings has been referred to above. That the great triple shafts at 18 c were carried up to the wall-head when the idea of vaulting was abandoned is proved, as on the east side, by the setting-out of the clearstory arcade. As on the east side, the arcade consists of wide plain semicircular arched openings in front of the windows, flanked by narrow openings with their semicircular arches springing from the same level. As however there are here no vaulting shafts in the triforium stage, the arrangement of these narrow openings is somewhat different. In the northern double-bay (18 ac) there were two openings between the two windows and a single opening beyond each window, forming with the window openings an arcade of six in all (fig. 7, iii). In the southern double bay (18 ce) the single window was flanked by two narrow openings on each side, making an arcade of five in all. Three of these narrow openings still remain open,² but the others were walled up or removed when the existing vault was built.³ The

¹ *Billings*, pl. 14.

² *Billings*, pl. 14, only shows these three openings.

³ Where the original jambs do not remain, the position of the destroyed openings is indicated by the little groins in the barrel-vault of the wall-passage.

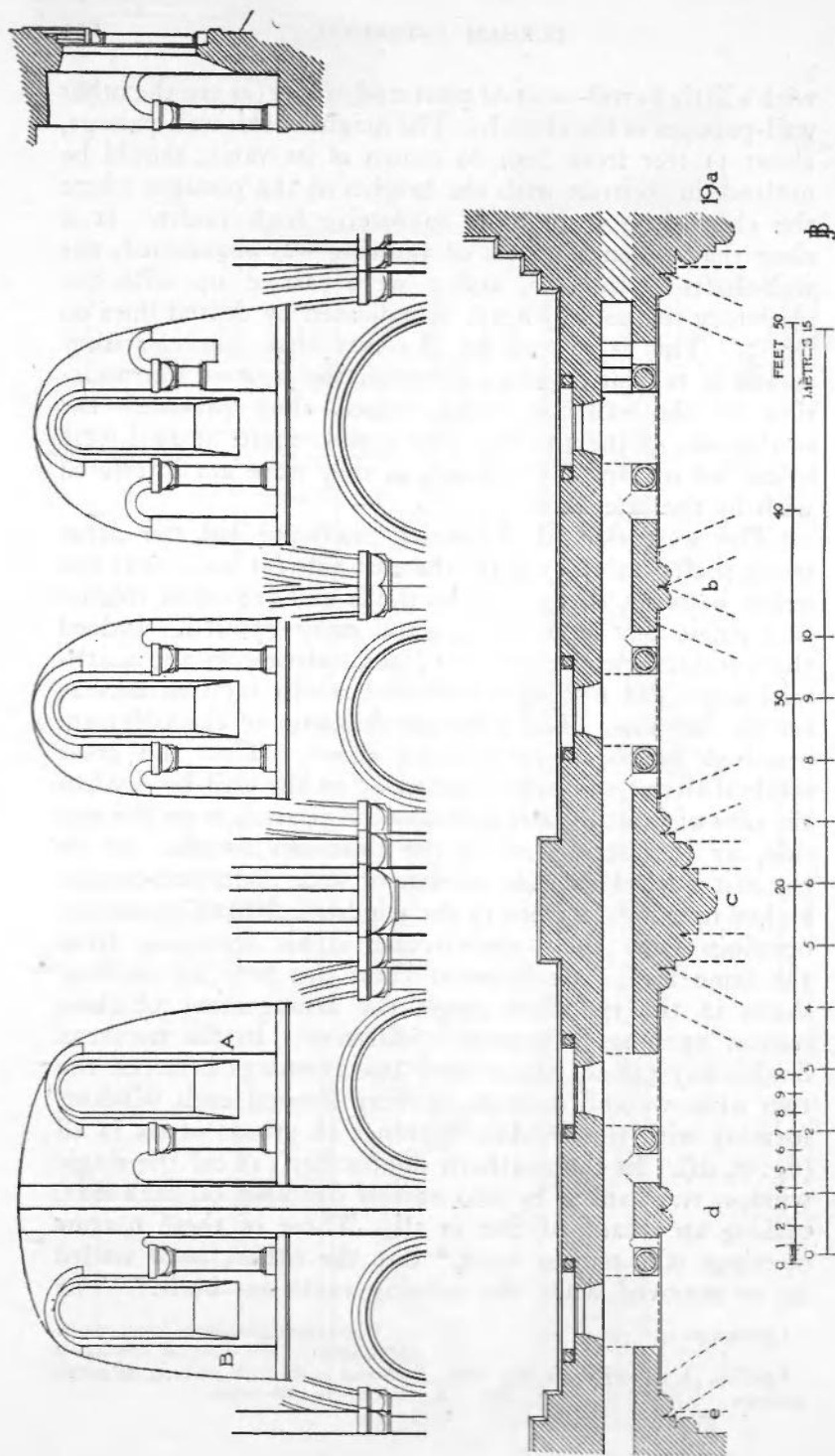


FIG. 6. NORTH TRANSEPT, EAST CLEARSTORY.

wall-passage behind these openings is more than 11 feet high from floor to crown of its little barrel-vault.

The construction of the clearstories of the south transept deserves special attention, because it shows what might be expected in the north transept and nave, if their vaults had been added subsequently, as was the vault of the south transept. That this part of the church should be wood-ceiled was not in itself unusual, for in many Romanesque churches only the eastern arm was vaulted. Nevertheless, in view of the complete preparation for a vault in the earlier part of the work, it is unfortunate that the first intention was not immediately realized. We have no direct evidence of the date of the completion of the south transept, but I think it is most probable that it was finished much about the same time as the choir.¹

In each of the four internal angles of the CROSSING crossing there is a single attached shaft which was obviously designed to receive a vault. Whether such a vault was actually built over the crossing, it is impossible to say, for the upper part of the central tower was rebuilt in the fifteenth century. The shafts are original up to about one-half or two-thirds of the height from the springing of the crossing arches to the later gallery above,² but the walling shows that there has never been any vault below the level of this gallery. If however the usual Norman Romanesque type of lantern tower was adopted here, any vault would of course be above this level.

What has been said above of the ground NORTH TRANSEPT and triforium stages of both sides of the south transept may be taken as applying equally to the north transept. Evidently the two arms of the transept were being built at the same time, the south a little in advance of the north because the conventual buildings were on the south side of the church. The east side of the north transept³ shows the same complete preparation for a high vault as in the choir and south transept; the

¹ The wood ceiling of the south transept would of course be constructed in very much less time than the vault of the choir.

² *Billings*, pls. 4, 11, 15, and 49.

³ *Billings*, pl. 15.

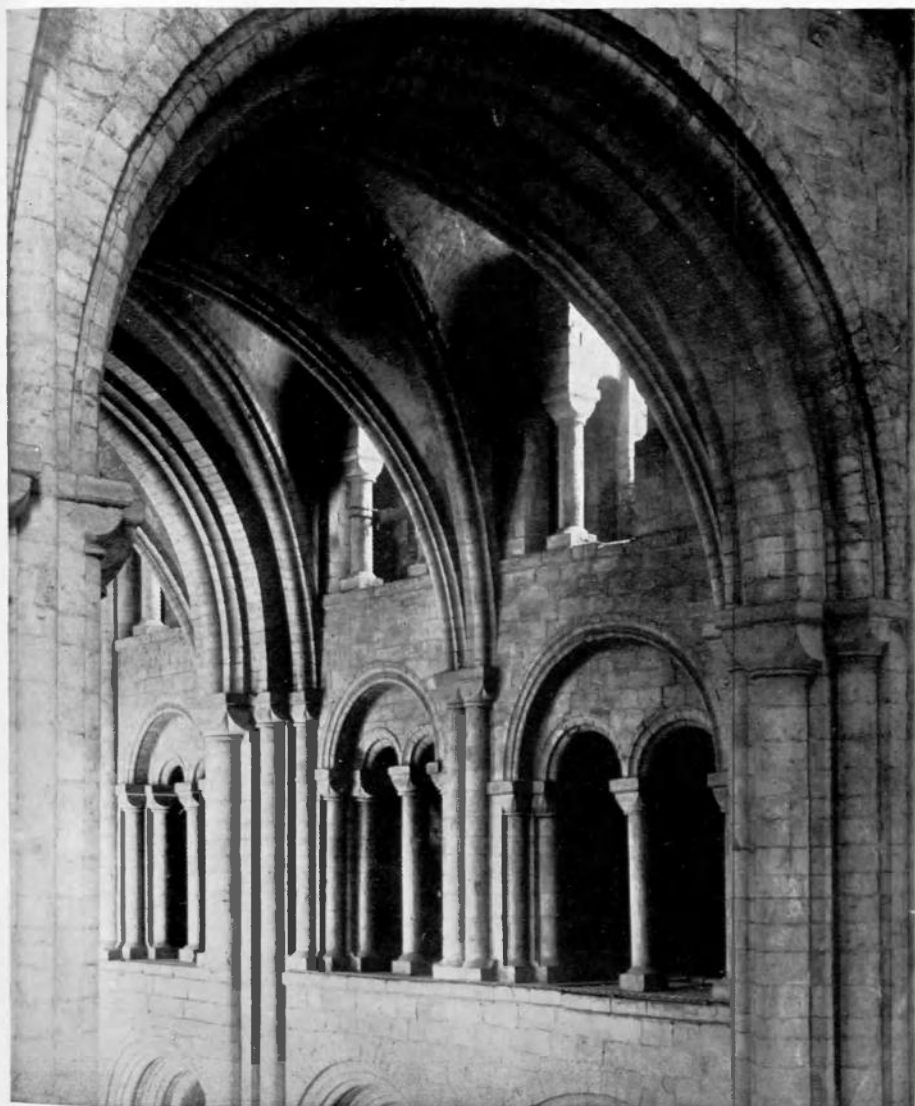
face of the triforium stage is set back to receive the vaulting shafts, and the semicircular abutting arches form part of the original build. Here however the first conception was realized, and the high vault was built (plate VII). The triple shafts on the face of the major pier (19 c) and the vaulting shafts which start from the triforium string (at 19 abce) are finished with capitals at the same height as those of the crossing pier (fig. 6). These capitals were built with the walls; the walling above them and the clearstory strings finish neatly up to the vault, and they show nothing of the patchwork visible in the south transept where the capitals and vault were later insertions. At the north-east angle (19 e) the two capitals were clearly built with the walls; that to the vaulting shaft which starts from the triforium string receives the ogive of the high vault, and that to the shaft which rises from the floor receives an unmoulded wall-arch on the north wall, repeating the outer order on the north side of the crossing arch which springs from a corresponding shaft (17 a and 19 a).

The west side of the north transept¹ has the great triple shafts (at 17 c) opposite those on the face of the major pier (at 19 c), and, as in the south transept, the space north of these shafts, up to the staircase in the north-west angle, is treated as a single bay. On the east side, the vaulting shafts in the triforium stage were planned for vaulting in two bays (19 cde), but the extreme narrowness of the northern bay (19 d e) would in any case have made this difficult, and with the single bay and angle staircase on the west side it became impossible. The whole space (17, 19 c e) was therefore covered with a single bay of vaulting, and the double shafts on the east side (19 d), which thus became useless, were carried up with the walling of the clearstory to the crown of the vault. On the west side the capitals of the great triple shafts (17 c) were probably built with the walls. As however no supports were provided in the triforium stage to receive the ogives of the vault, these spring from corbels. The wall appears to have been built up to the clearstory string before the corbels were inserted,² but the string itself finishes neatly up to the vault. The corbels themselves

¹ *Billings*, pl. 14.

² The southern corbel (at 17 a) is at the same height as the capitals of the crossing

pier, but the other corbels and the capitals of the triple shafts are placed several inches higher.



[C. C. Hodges, photo.]

NORTH TRANSEPT, EAST SIDE.

are of a much less advanced type than those in similar positions in the south transept and nave, and indicate a decidedly earlier date.

The clearstory arcade (fig. 6) shows three unmoulded semicircular arches, springing from plain outer jambs and from monolithic shafts with cushion capitals, a wider highly stilted arch in front of the window, flanked by a narrow and lower arch¹ on each side. We have seen that in the south transept, when the idea of vaulting was

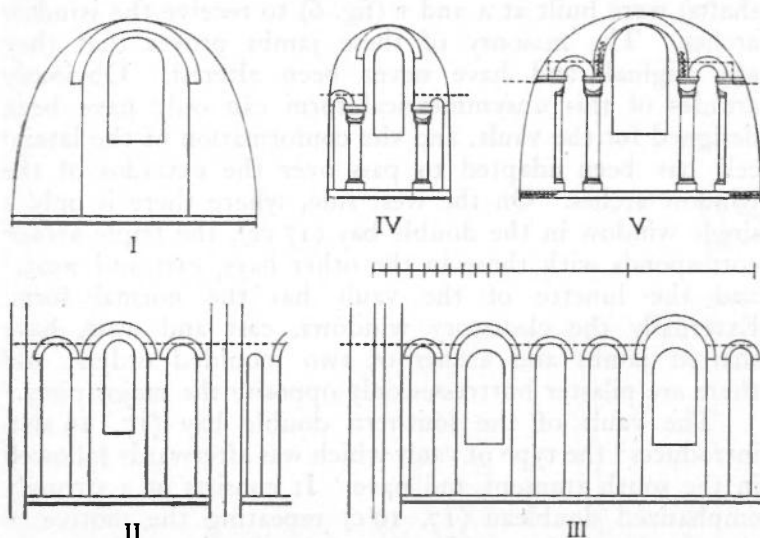


FIG. 7. COMPARATIVE ELEVATIONS OF CLEARSTORIES.

I, Choir (23, 25 a). II, South Transept, east side (20 ab). III, South Transept, west side (18 abc). IV, North Transept (19 bc). V, Nave (7, 9 a).

abandoned, the clearstory arcade with all its arches springing from the same level was obviously designed for the horizontal finish of the wall beneath a flat ceiling. Here in the north transept the clearstory arcade is just as obviously designed to fit the lunette of the vault (fig. 6, 19 abc). The wall-passage behind the arcade is only about 7 ft. 6 ins. high from the floor to the crown of its little barrel-vault—in contrast with the high wall-passage in the south transept.²

¹ Some of the narrow side openings are covered by lintels, cut out on the underside to the semicircular arched form.

² Compare the two sections on figs. 5 and 6. On fig. 7 the dotted lines show the crowns of the vaults over the wall-passages.

That the clearstory was designed for and built with the actual vault is proved by the arrangement of the arcade in the northern double bay on the east side (19 cde, fig. 6), which is vaulted as a single bay. The position of the clearstory windows, approximately central with the triforium arcade below, left room for a narrow opening on each side of the double shaft, but not sufficient space for corresponding openings on the other side of each window within any possible form of lunette. The openings were therefore omitted, and plain square jambs (instead of shafts) were built at A and B (fig. 6) to receive the window arches. The masonry of these jambs proves that they are original, and have never been altered. Obviously arcades of this unsymmetrical form can only have been designed for the vault, and the conformation of the lateral cell has been adapted to pass over the extrados of the window arches. On the west side, where there is only a single window in the double bay (17 ce), the triple arcade corresponds with those in the other bays, east and west,¹ and the lunette of the vault has the normal form. Externally the clearstory windows, east and west, have shafted jambs and arches of two moulded orders, and there are pilaster buttresses only opposite the major piers.²

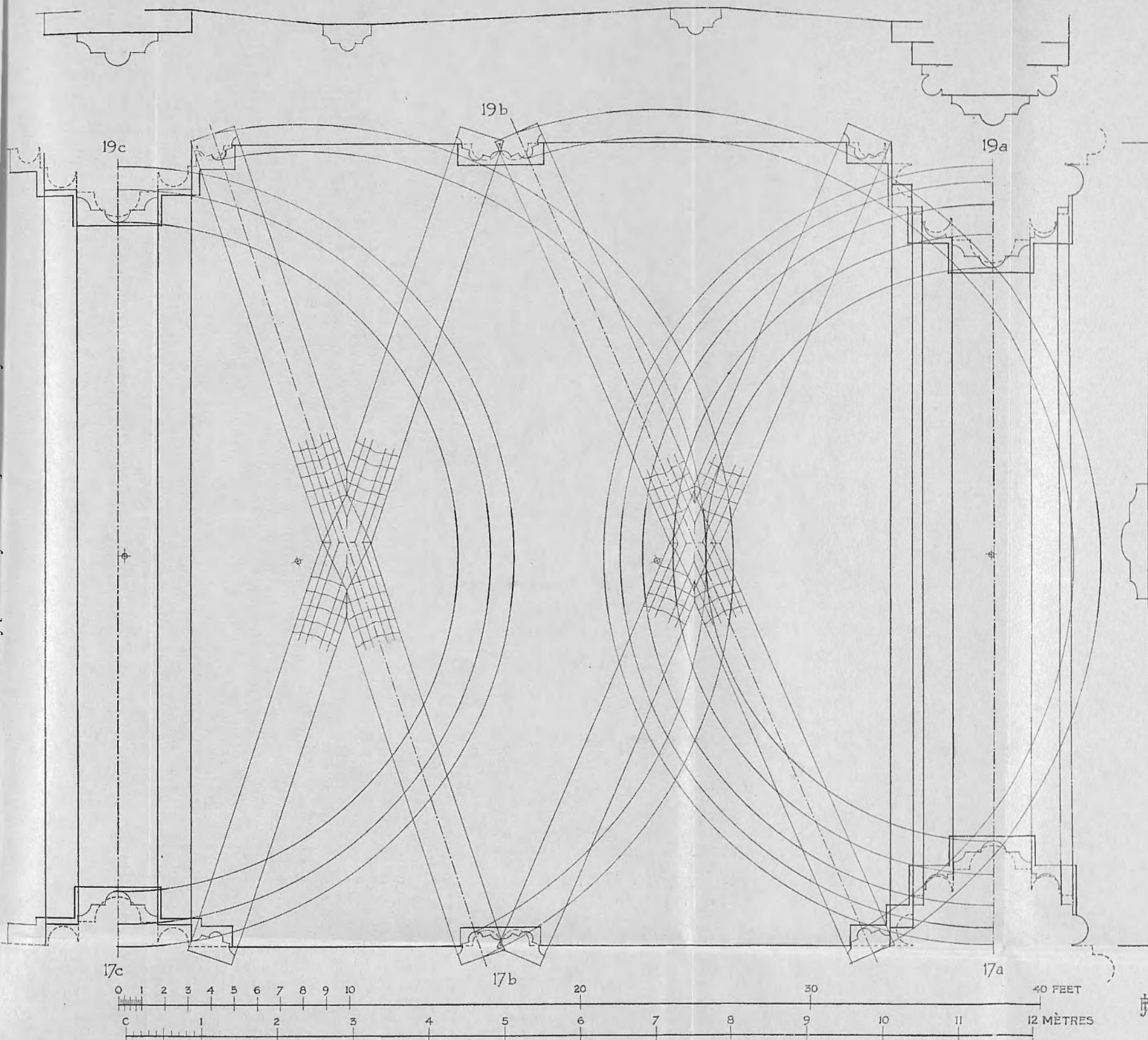
The vault of the southern double bay (17, 19 abc) introduces³ the type of vault which was afterwards followed in the south transept and nave. It consists of a strongly emphasized doubleau (17, 19 c) repeating the motive of the crossing arches, and two *croisées d'ogives* without any intermediate doubleau.⁴ The northern double bay (17, 19 cde), although its east wall was designed for a similar vault, is covered with a single quadripartite vault, for the reasons already noticed. The vault of the southern double bay is illustrated in detail in plate VIII. The system is the same as that of the vaults of the aisles of the choir and transept. The curve of the doubleau (17, 19 c), like that of the crossing arch (17, 19 a), is a semicircle slightly stilted. The curves of the ogives are segments of circles struck from centres below the springing line. As the

¹ Billings, pl. 14.

² Billings, pls. 13 and 16.

³ As suggested above, the original vault of the choir was probably of the same type.

⁴ It is in itself improbable that this unusual type would have been adopted at a later date when vault construction had become systematized.



NORTH TRANSEPT, PLAN OF VAULT.

narrowness of the bays reduces the spans of the ogives, the centres of their curves are not very far below the springing line—a little less than 2 feet in bay 17, 19 ab, and a little more than 2 feet in bay 17, 19 bc.¹ The crowns of the vault are nearly level.² The curves of the lunettes on the side walls (19 ab and 19 bc, fig. 6) are tall quasi-semi-ellipses, which do not result from projecting the groin curves perpendicularly to the wall (as in the unribbed vault), but the lunettes and the clearstory arcades were designed together. The curves of the lunettes thus controlled the conformation of the lateral cells, which were built on straight centering boards between the ogives and lunettes. The result is a pronounced plough-sharing of the lower part of the lateral cells. The middle cell is built barrel-fashion, as in the nave vault.

The doubleau (17, 19 c) is of two orders, the outer orders unmoulded, and the wide inner order moulded with a roll between two hollows, the same profile and the same size as the inner order of the crossing arches. The ogives are also moulded with a roll between two hollows, as in the vaults of the aisles of the choir and transept. The keys of the ogives are not shouldered, but are of the lozenge shape (plate viii) already noticed in the vaults of the aisles of the choir and transept. The ribs are constructed of thin stones. The cells are built of rubble, and plastered.

The vault of the north transept is probably the earliest surviving example in the Norman school of a high vault with ogives.³ Its date is therefore of considerable importance. We have seen that the clearstory was built for and with the vault, and the clearstory takes its place in the regular order of building from choir to nave. The profiles of the members of the vault correspond with those of the crossing arches and of the vaults of the aisles of the choir and transept. When the works were resumed in the nave, westward of the two easternmost bays, the chevron ornament was introduced in the arcade arches and ogives

¹ About one-ninth and one-seventh respectively of the height from springing to crown.

² Although plate viii cannot claim the precise accuracy of the drawings of the nave vault (plates xiii and xiv), where everything was measured from the scaffold, it is as nearly accurate as is possible without actual

measurements of the heights of the crowns longitudinally. I have to thank Mr. W. T. Jones, F.S.A. for his kind assistance in ascertaining the heights of the crowns.

³ The high vaults of the choir and transept of Lessay (Manche) are probably only slightly later.

of the aisle vaults, and thenceforward is used profusely in the decoration of the arches. There is no trace of this in the north transept. The conclusion therefore is that the vault of the north transept was built before the resumed works in the nave had reached the arcade arches. The nave was finished *usque testudinem* by 1128, and in estimating the time to be allowed for its building we have to remember the *modo intentius, modo remissius* of the chronicler, and the fact that, when the eastern parts of a monastic church had been finished, the nave was generally built more slowly. These considerations suggest that the resumption of work in the nave cannot be placed later than the end of the first decade of the twelfth century. The conclusion therefore is that the vault of the north transept must have been built somewhere about 1110.¹

There can be little doubt that the abandonment of the high vault in the south transept was due to the insufficient resources at the disposal of the monks. The great translation of 1104 was a notable event in the history of the church, and it excited widespread interest and enthusiasm. The offerings of the devout at the shrine of the saint in its new and stately setting must surely have increased to an extent which would substantially improve the financial position. Is it unduly bold to suggest that this may have made it possible to build the vault over the north transept which had been intended by the first master ?

Before dealing with the vaults of the nave and its aisles, it may be convenient to describe the vault which was added in the south transept in place of the original wooden ceiling. This vault² follows the plan and system of that of the north transept, the only difference being the addition of the chevron ornamentation. We have seen that, when the idea of vaulting was abandoned for a flat ceiling, the vaulting shafts were continued up to the top of the wall (fig. 5). It was therefore necessary to insert capitals to these shafts to receive the members of the added vault. The capital to the vaulting shaft on the east side next the crossing

¹ Admitting the proved order of the works, any difference of opinion as to the time to be allowed for each section can

only affect this suggested date by very few years.

² *Billings*, pls. 14 and 15.

(20 a) was inserted at a rather higher level than the capitals of the crossing pier. On the major pier (20 c) the capital to the southern shaft of the group of three which rise from the floor has its cushion subdivided into two, though the capitals of all the other high shafts throughout transept and nave are single cushions. The tooling of the added capitals is finer and smoother than that of the original work. In the south-east angle (20 e) the shaft originally planned as a vaulting shaft had been carried up the wall, and the ogive of the added vault springs from the adjoining shaft which rises from the floor¹ (fig. 5). On the west side, capitals were inserted to the triple shafts (18 c) to receive the doubleau, and corbels were inserted to receive the ogives, as on the west side of the north transept. The corbel next the crossing (18 a) is at a higher level than the capitals of the crossing piers. The corbels are of more advanced type than those on the west wall of the north transept, and the sculptured heads (plate ix, 1) are similar to those on the corresponding corbels in the nave. The clearstory string has generally been roughly cut away to allow the ogives to pass, and the bad fitting here may be contrasted with the neat junction of string and shafts at 20 d where the shafts, not being required for the added vault, remain as originally carried up the wall.

The semicircular doubleau which springs from the triple shafts on the face of the major pier (20 c) and from the corresponding shafts on the west wall at 18 c (plate ix, 1) is of two orders, the wide inner order being moulded with a roll between two hollows (as in the north transept), while the outer order on each side is worked with chevron ornament similar to that on the outer order of the nave arcade arches. The outer order on the south side of the crossing arch (18, 20 a) is also ornamented with chevrons. The ogives have a roll flanked by chevrons² of the same type as those on the ogives of the nave vault, but slightly simpler. The key of the ogives of the southern bay (18, 20 d) has the lozenge shape already noticed, but the keys in the two other bays (18, 20 ab, and 18, 20 bc) are jointed at right angles to the direction of the rib, a less primitive method which in the nave vault is only found in a western

¹ Billings, pls. 15 and 50.

² For detail, see *Journ. R.I.B.A.* vi, 346.

bay. In other respects the system and construction is the same as in the vault of the north transept. The vault masks parts of the clearstory arcades, and its addition necessitated the rebuilding of the inner half of the clear-story wall behind the abutments, and the consequent blocking or suppression of most of the narrower openings of the arcade.

With regard to the date of the addition of this vault, we have no evidence beyond what is indicated by the character of the work itself. It was certainly built while the nave was in course of construction, and certain details indicate that it is of slightly earlier date than the vault of the nave.

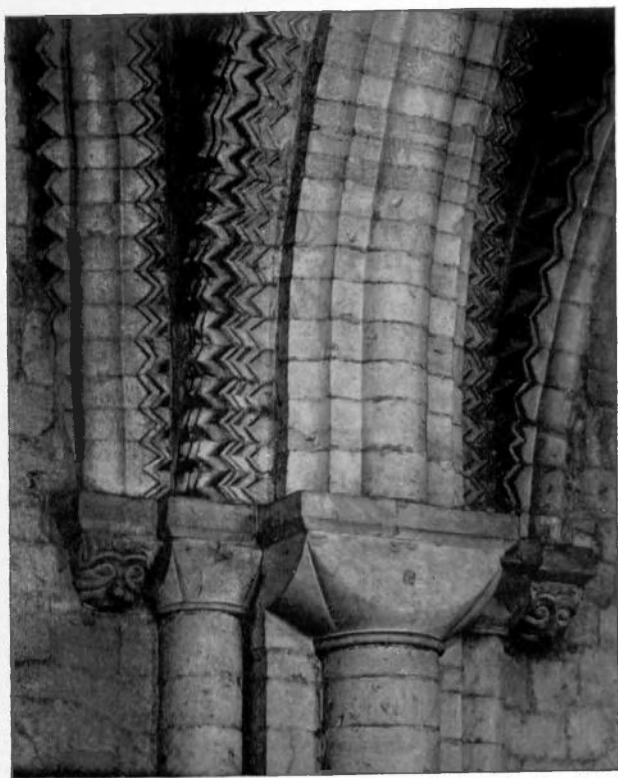
AISLES OF NAVE

The vaults of the two eastern bays of the aisles of the nave (13, 15, 17 ab; 14, 16, 18 ab), which form the limit of the first great building-campaign, have already been described. The vaults of the remaining bays of the aisles (3 to 13 ab, and 4 to 14 ab) are precisely the same, both in system and detail, except that the profile of the ogives is different. In the aisle vaults throughout the first campaign, the ogives are profiled with a roll between two hollows (fig. 2, v). In the vaults of the later bays (from 13 ab and 14 ab westward) the ogives have chevrons on each side of the roll, instead of hollows. The chevrons are of precisely the same type as those in the arcade arches,¹ where the chevron ornamentation begins at the same point (13 a, 14 a).

The vaults of the western bays beneath the towers (1, 3 ab; 2, 4 ab) show a variation of system which is worth notice. As the towers project considerably beyond the walls of the aisles, the ogives of the vaults of these bays have a greater span than those of the other aisle vaults. The capitals of the shafts which receive the ogives are therefore placed at a lower level than the capitals which receive the arches opening into the nave and aisle (plate ix, 2), in order to give greater height to the ogive by thus lowering its springing. These two vaults may be attributed

¹ These chevrons, modelled on a convex profile as noted above, start with a roll on each side, instead of fillets as in the doubleaux and ogives of the high vault of the nave (fig. 9). In the arches of the nave triforium,

the chevrons on the inner orders also start from rolls, but those on the outer order of the south triforium have a single roll between the fillets.



[F. Lefevre-Pontalis, photo.]

I. SOUTH TRANSEPT, SPRINGING OF VAULT (18 c.).

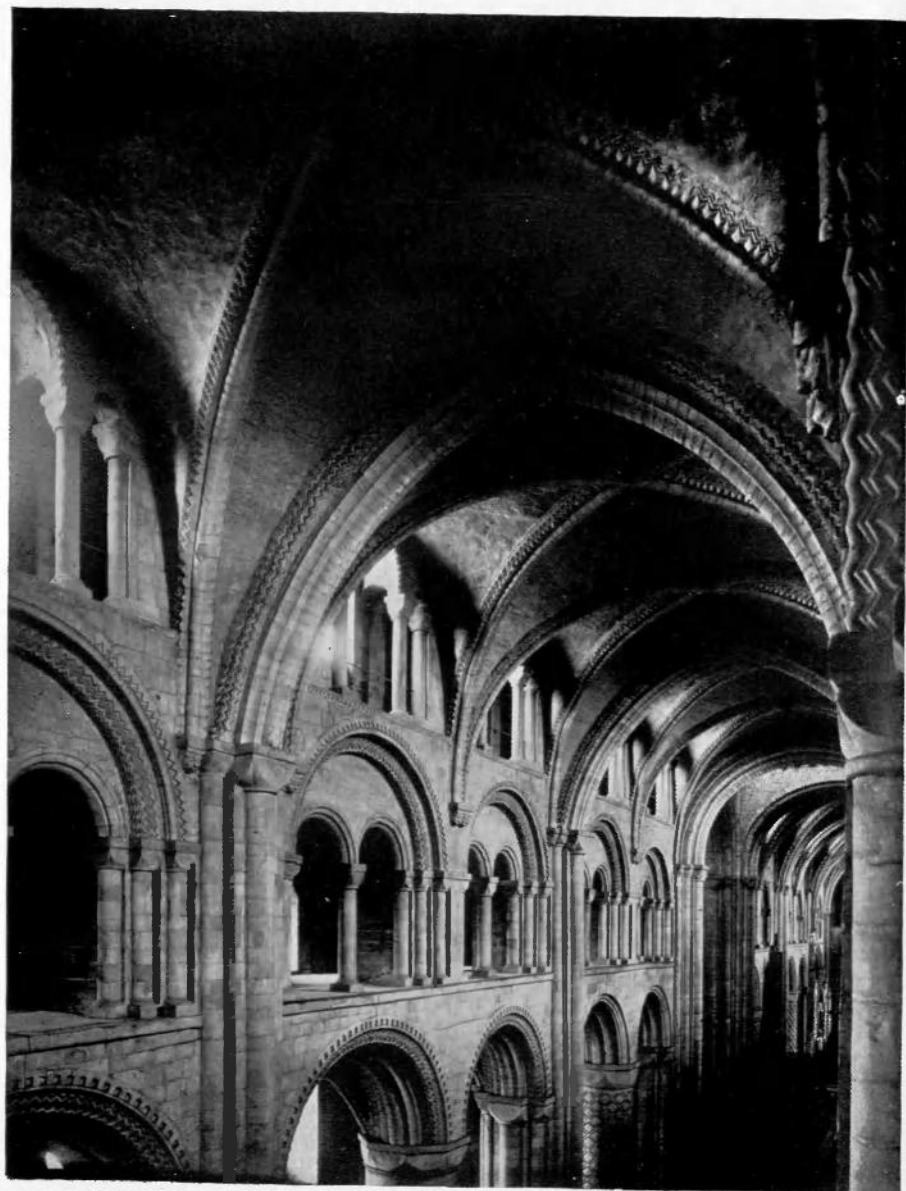
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[J. P. Freeman, photo.]

2. VAULT UNDER NORTH-WEST TOWER (3 a).

PLATE IX.



NAVE, NORTH SIDE.

[E. Lefèvre-Pontalis, photo.]

to a date somewhere near 1120. The same expedient was adopted in the interesting vault of the choir of the old church of Saint-Paul, Rouen,¹ which is probably of about the same date. A similar arrangement, with pointed arches, was followed in Suger's work at Saint-Denis beneath the western towers² (1137-1140).

NAVE The nave (plates 1 and x) is divided into double bays by the great triple shafts which rise from the floor on the face of the major piers, and receive the great doubleaux—three double bays from the crossing westward, followed by two single bays. Each of the double bays is vaulted with two *croisées d'ogives* without intermediate doubleaux. The first single bay (3, 4, 5, 6 a) is covered with a single quadripartite vault, as also is the western bay between the towers (1, 2, 3, 4 a) where the vault has a central eye.

Plates XIII and XIV represent a carefully measured survey of the vault which I was fortunately able to make in 1915 from the scaffolding which was erected for the repair of the vault.³ The close examination which then became possible supplemented and to some extent modified my previous description, and furnished some interesting information as to the precise construction of the vault.

We have seen that, when the triforium stage of the west side of the transept⁴ was built, the vaulting shafts of the east side were not reproduced, and no special provision was made for receiving the members of the vaults, and that in the south transept this was followed by the substitution of a flat ceiling for the vault which was originally intended. In the bays of the transept next the crossing (17 ab, 18 ab) the triforium openings have only a single shaft to each jamb, and an unmoulded containing arch.⁵ This work was continued around the western piers of the crossing to include the eastern bay of the triforium of the nave

¹ Now serving as the sacristy of a modern church. The existing remains of the old church were fully described and illustrated by my friend, Dr. Coutan, in the *Bulletin de la Société des Amis des Monuments Rouennais* for 1920-1.

² Dehio and von Bezold, *Die Kirchliche Baukunst des Abendlandes*, pl. 153, fig. 8.

³ I have to thank the present Bishop of Durham (Dr. Hensley Henson), who was

then Dean of Durham, for very kindly giving me every facility for studying the vault from the scaffolding, and also for his kind permission to reproduce the photograph (plate xv) which was taken for the Dean and Chapter by Mr. J. R. Edis of Durham, before the cells of the vault were replastered.

⁴ Billings, pl. 14.

⁵ Billings, pls. 14 and 49.

(15, 17 a ; 16, 18 a), which here forms the termination of what I have called the first great building-campaign. The plan of the eastern jamb of the triforium opening in this bay is similar¹ to that of the openings next the eastern crossing piers in the triforiums of the choir and transept—three shafts, the inner receiving the sub-arch, and the middle one the moulded containing arch. Here however the outer shaft, which in the choir and transept is continued up the recessed wall-face as a vaulting shaft, is finished with a capital at the same level as the others, and receives an unmoulded outer order of the arch.² The standard wall-thickness of 7 feet, which in the choir and transept is reduced 11 inches by the recessing for the vaulting shafts, is thus retained throughout the nave triforium, the wall-face being the same as that of the arcade spandrels below. The work here shows some uncertainty of handling, and both on the north and south sides (15, 17 a ; 16, 18 a) the square-edged outer order is not concentric with the moulded inner order. On the west side of the bay, these jamb shafts are repeated on each side of the pier (15 a, 16 a) over the minor pier of the great arcade, with a narrow strip of wall-face between the two outer shafts. Here the work of the first building-campaign ends. It is important to note that this omission of any preparation for a high vault occurs in work which is part of the same build as the triforium stage on the west side of the transept, where there are no vaulting shafts, and that in the south transept this was closely followed by a clearstory stage designed for and actually receiving a wood ceiling.

Some considerable time must have elapsed between the building of this easternmost bay of the triforium and the continuation of this stage westward, for, on the resumption of work in the nave, some bays at least of the arcades must have been built before the continuation of the triforium was begun. In the second campaign, the jamb shafts on each side of the triple shafts of the major

¹ A small difference of detail may be noticed. The inner shaft throughout faces the direction of the arch. In the choir and transept, the next shaft also faces in the same direction, while the outer shaft, which is a vaulting shaft, faces outwards. In the nave the outer shaft, which has become a

jamb shaft, faces outwards, and the second shaft also faces outwards. This last only occurs elsewhere at one point in the choir, in the eastern jamb of the easternmost bay of the triforium (27 a, 28 a).

² Illustration in F. Bond, *Gothic Architecture in England*, 8.

piers (plate XI, 1) repeat the plan of those next the crossing piers, and the minor pier (at 15 a, 16 a) is repeated in the middle of each double bay. These control the setting-out, and govern the width of the openings.¹ The only other material change is the chevron ornamentation of the two orders of the containing arch already noticed.

It has generally been assumed that, when the arcade and triforium stages of the nave were built, the idea of a high vault had been abandoned. I doubt whether this is true of the works of the second campaign. We have seen that the elimination of the vaulting shafts in the easternmost bay of the triforium dates from a time when this unfortunate change of plan was contemplated, and actually carried out in the south transept. It is difficult to see however how the builders of the second campaign could well have done otherwise than follow in the triforium what had already been built in the easternmost bay. They may quite conceivably have intended to build a high vault with the corbel supports which had perforce been adopted on the west side of the north transept, and the fact that the high vault there had already been built tends to confirm this view. However this may be, we shall see that, before the clearstory stage was reached, the high vault formed an integral part of the programme.

The piers of the triforium are reinforced at the back by broad pilasters, 5 feet and more in width, of single projection behind both the major and minor piers. On the easternmost pier on the north side (15 a), which is part of the first work, some want of correspondence in the bed-joints of the upper part of the pilaster may perhaps indicate that the first intention here was to build a semi-circular abutting arch, as in the choir and transept, but there is no such indication on the corresponding pier on the south side (16 a). The vault is abutted by half-arches, of the same width as the pilasters, across the triforium stage beneath the roof (plate VI, 2),² a far more effective method of receiving the thrust than the semi-circular arches in the choir and transept. On the outer

¹ Narrowest in the easternmost bay (15, 17 a; 16, 18 a), because the clear width of the arcade below is less (p. 112, n. 1 above); wider in the next two bays; wider

still in the following three bays; and narrower again in the bay to the east of the towers (3, 5 a; 4, 6 a).

² *Billings*, pls. 13 and 43.

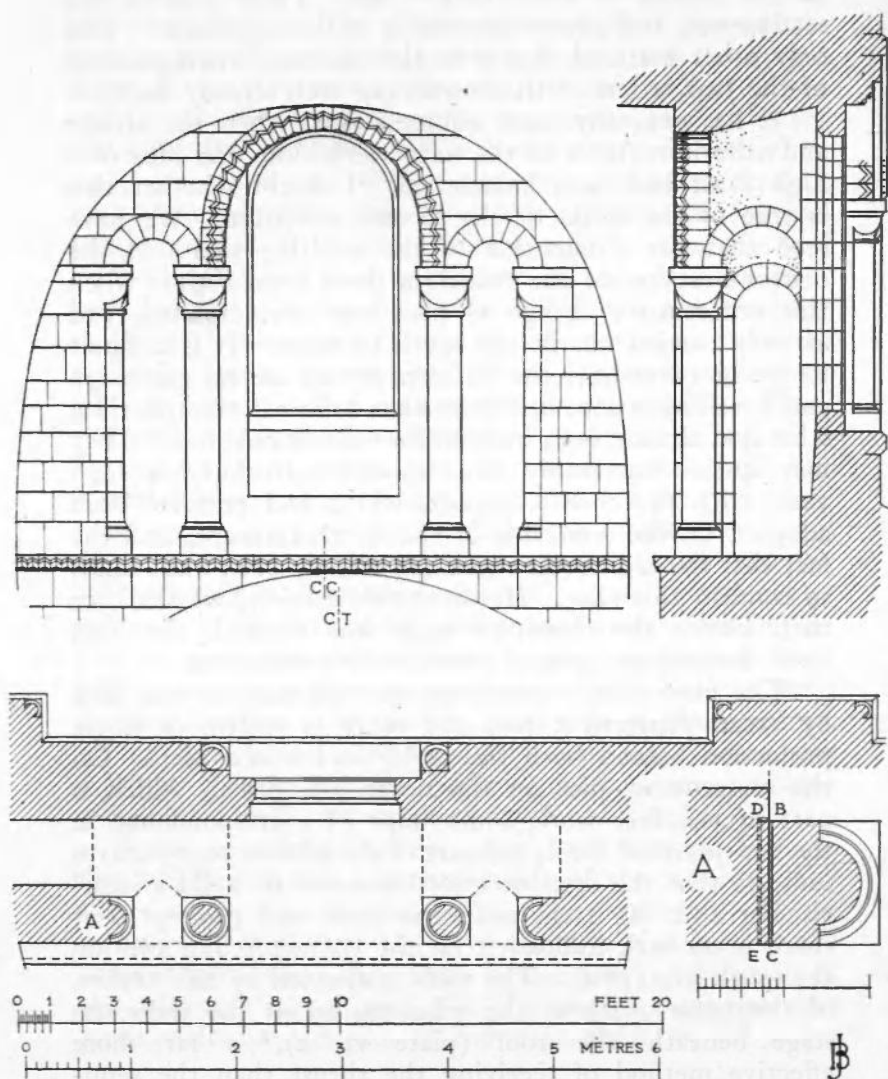


FIG. 8. NAVE CLEARSTORY (7, 9a).

wall of the triforium stage the arches spring from short pilasters with chamfered plinths. These plinths and the courses immediately above them were built with the wall, which indicates that preparation was already being made for the abutment of the high vault. The arches themselves¹ could only be built when the outer and inner walls had been carried up to a sufficient height to receive them. Similar rudimentary flying-buttresses exist in the nave triforium of Sainte-Trinité, Caen,² and were prepared for, if not actually built, throughout the triforium stage of Norwich cathedral.³

The string-course below the clearstory is decorated with chevrons up to the west side of the crossing, and, with the whole clearstory stage, belongs to the second campaign. The internal face of the wall on the north side of the nave (3 a to 17 a) is set back a little behind the wall-face below the clearstory string. The set-back is not uniform, but generally varies between $1\frac{1}{2}$ and 6 inches.⁴ On the south side, the set-back either does not exist or is scarcely perceptible in most of the bays, and nowhere exceeds $2\frac{1}{2}$ inches. The height of the clearstory stage internally is about 1 foot more than in the north transept,⁵ and seems to have been governed by the vault.

The clearstory arcade (fig. 8) is of the same type as that of the north transept, but of different proportion and more advanced character—a triple arcade designed to fit the lunette of the vault. The semicircular arches spring from monolithic shafts and from outer jambs with attached shafts, with cushion capitals. The wide stilted arch in front of the window is decorated with chevrons, but the narrow arch on each side is unmoulded. The middle of the curve of the lunette is tangential to the extrados of the wider middle arch. The little-barrel vault over the wall-passage behind the arcade springs from the level of the tops of the capitals, and the narrow side arches of the arcade are groined into it. This level is however only

¹ These arches were underbuilt with two additional orders in 1914. For a criticism of this operation, see *Proc. Soc. Antiq.* 2nd ser. xxviii, 52. Mr. Saunders' photograph (plate vi, 2) was taken before this addition was made.

² *Congrès archéologique de Caen* (1908), 11. *Congrès archéologique de Paris* (1919), 375.

³ F. Bond, *Gothic Architecture in England*, 371.

⁴ See the section on fig. 8.

⁵ Height from top of clearstory string to crown of lunette of vault: north transept, east side (19 ab), 12 ft. 10 ins.; nave, generally about 13 ft. 11 ins.

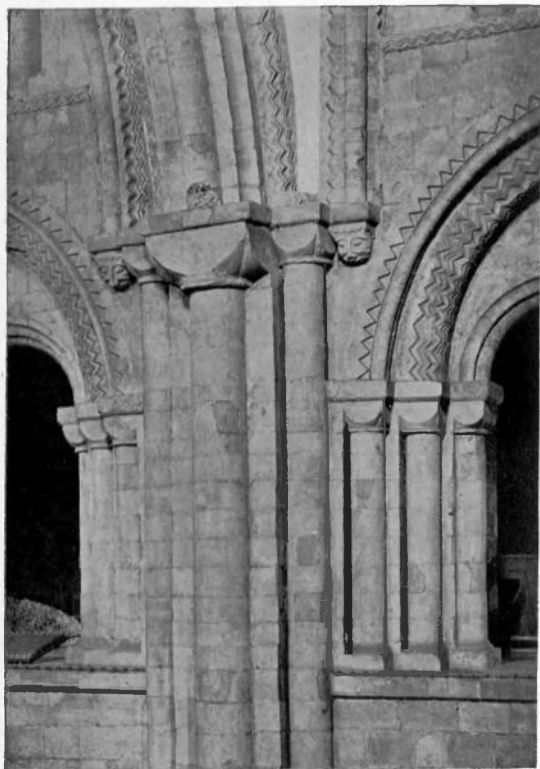
continued to the break beyond the jamb shafts, from which point the barrel-vault springs from the level of the bottom of the capitals, thus reducing the height of the crown of the vault from 10 ft. 2 ins. to 8 ft. 5 ins. If there had been no question of a high vault over the nave, there would have been no reason why the higher barrel-vault over the passage should not have been continued through the pier between each bay. The level was lowered in order to avoid unduly weakening the abutment of the high vault.

Externally the clearstory windows have shafted jambs, and arches of two orders, the inner order being ornamented with chevrons. There are pilaster buttresses opposite both the major and minor piers, and the angles of the buttresses are shafted.

It has been suggested that the clearstory arcades in their present condition represent an alteration from an original arrangement designed for a wood ceiling,¹ but the suggestion is untenable. The very slight break-joint of the first vertical joints beyond the shafted jambs has given the erroneous impression that these jambs have been added to the walling beyond, although the bed-joints range accurately. The true explanation of the defective jointing of the masonry is indicated by the detailed plan at A on fig. 8. The inner ends of the jamb stones are jointed alternately (1) in line with the break in the passage, as indicated by the strong lines BC, and (2) tailing in a little beyond, as the dotted lines DE. The whole of the clearstory is certainly a homogeneous work; the chevrons on the arches in front of the windows are of precisely the same type as those of the triforium arches below; and the chevron string-course has never been altered.

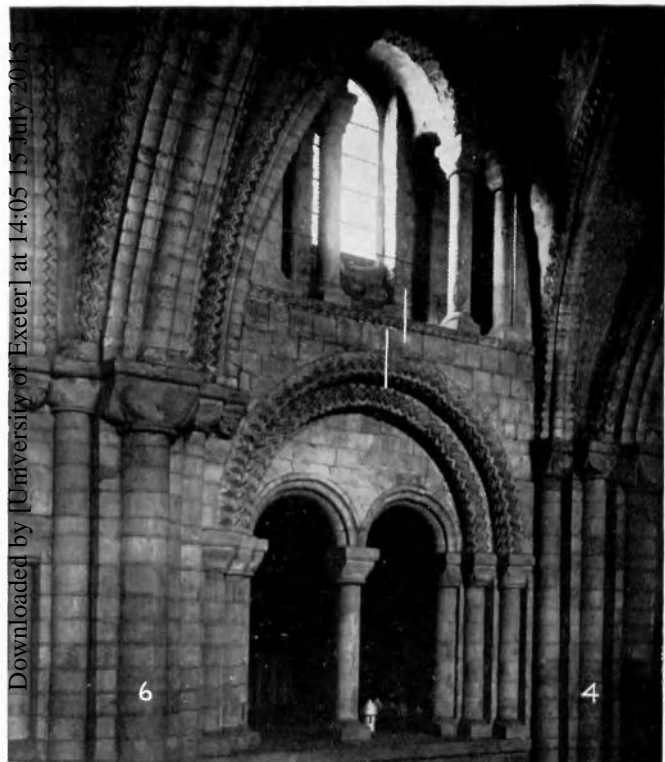
Another detail which has been supposed to indicate a wood ceiling is to be seen at the springing of all the doubleaux of the nave vault. These have two orders, of which the outer order is ornamented with chevrons. The lowest voussoir of the outer order at every springing is some 5 to 7 inches wider than the voussoirs above it (plates x; xi, 1, 2). This has been interpreted as indicating the intention to build transverse arches across

¹ In my earlier paper (*Journ. R.I.B.A.* vi, 314), I accepted this suggestion, which subsequent examination has shown to be erroneous.



[F. H. Crossley, photo.]

I. NAVE TRIFORIUM, NORTH SIDE (I3 a).



[E. Lefèvre-Pontalis, photo.]

2. NAVE TRIFORIUM AND CLEARSTORY, SOUTH SIDE (4, 6 a).

To face page 147.

the nave, and to cover it with a wood ceiling,¹ or that such arches (carrying a wall or transverse gable) were actually built.² The *arc diaphragme* has received rather more than its fair share of attention from some writers on Norman Romanesque architecture, considering the very small number of proved examples, but there is certainly no reason for introducing it at Durham. Such arches carrying walls of the extraordinary thickness of $5\frac{1}{2}$ feet or more are in the highest degree improbable. In the only part of the church where it has been possible in recent years to examine the internal face of the wall above the high vault—in the north transept—it is certain that no such transverse wall has ever existed. Moreover the motive of the high shafts on the major piers is constant throughout the four arms of the church, and in the other three their function is certain. In the choir the shafts received the doubleau of the original vault of which definite proofs exist. In the north transept they receive the doubleau of the existing original vault. In the south transept, where the conditions which this theory presupposes for the nave did actually exist, no *arc diaphragme* was built to receive the wood ceiling, but the shafts were continued up to the top of the wall. Why then should an entirely different procedure have been adopted in the nave? The true explanation is quite simple. The wider voussoirs at the springing are precisely like those of the doubleau of the south transept vault (plate ix, 1), and were built on the capitals as the work went up. When the walls had been carried up to a sufficient height to enable the arches (and vault) to be built, the soffit-width of the outer order was reduced in order that the ogives might clear themselves better at the springing (plate xi, 1). It should be noted that these wider voussoirs at each springing were prepared for semicircular doubleaux, as in the south transept, and not for the actual pointed segmental doubleaux. The lowest voussoir of the inner order at the springings over the piers 3, 4, 5, 6, and 10 also appears to have been built as the work went up, for semicircular doubleaux. At the other springings (9, 13, and 14 a) the

¹ G. T. Rivoira, *Lombardic Architecture*, i, 237, 241, where however the nave vault is dated as before 1133.

² R. de Lasteyrie, *L'architecture religieuse romane*, 503-4.

segmental curve of the inner order starts directly from the top of the capital.

We come now to the much discussed question—was the existing vault of the nave built as its original covering, or was the nave originally covered with a wood ceiling, for which the existing vault was substituted at some later date? A close examination of the actual structure will enable us to give a very definite answer to this question.

(1) It has been thought that the corbels from which the ogives spring were later additions, inserted after the walls had been carried up.¹ This idea certainly derives some support from the corbels on each side of the major piers, where in some cases the abacus of the corbel does not exactly fit the abacus of the capital of the high shaft. In one case (east side of 5 a) I noticed that the chamfer on the abacus of the shaft is continued beyond the internal angle formed by the face of the corbel abacus. The evidence of the other corbels however suggests that this defective fitting is more probably due to inaccurate working of the stones before fixing. It is worth notice that at the one point, next the crossing (17 a and 18 a), where it would have been necessary to insert the corbel in earlier walling, that of the first campaign, no corbel was inserted, but the ogive was made to spring from the shaft which was designed to receive the outer order of the crossing arch. The next pair of corbels—the first of the double corbels (15 a, 16 a)—has doubtless suggested the idea of after-insertion. They occur at the point of junction of the masonry of the first and second campaigns; on their eastern side they are certainly inserted in the masonry of the first campaign, but on their western side the three bed-joints (top and bottom of abacus and bottom of corbel) range with the walling, as indeed they do most generally throughout. I think there can be no doubt that the other double corbels (11, 12, 7, 8 a) are of the original build. Plate XII, 1 shows how the corbel at 7 a is in perfect bond with the walling, and how a shallow course has been walled under the corbel purposely to receive it at the proper height.² It is obvious that this is no case of after-insertion.

(2) The setting-out of the clearstory in relation to the

¹ So in my previous description, *Journ. R.I.B.A.* vi, 314.

² Cf. plate XII, 2 for 11 a.

triforium stage below next demands attention. If there had been no question of a vault, the obvious plan would have been to place the clearstory windows centrally over the triforium arches, but this is not the case on either side of the nave,¹ and the setting-out of the vault furnishes the reason why. The single corbels which receive the ogives next the major piers are placed close up to the capitals of the high shafts, and the double corbels in the centre of each double bay are placed over the centre of the minor pier of the triforium. The result is that the centre line between the corbels is a few inches nearer to the centre of the double bay than is the centre line of the triforium arcade. In other words, in each double bay the width between the centre lines of the corbel spacing is considerably less than the width between the centre lines of the triforium. The clearstory arcade is not centred with the triforium, but in every case² the centre is moved in the direction of the centre between the corbels, so as to be practically central with the lunette of the vault,³ which was of course controlled by the position of the corbels. The setting-out of the clearstory was therefore controlled by the vault.

This can be seen even more distinctly on both sides of the single bay (3, 5 a; 4, 6 a) to the east of the bay between the towers. The piers 3 a and 4 a have an additional shaft on each side of the usual triple shafts which receive the doubleau. On the west side of the bay, the ogive springs from this additional shaft, while on the east side the ogive springs from the usual corbel (plate xi, 2). Consequently the centre of the lunette of the vault is considerably to the west of the centre of the triforium arcade below, and the centre of the clearstory arcade is central with the lunette.⁴ The setting-out of the clearstory arcade was therefore controlled by the vault.

¹ The difference is sufficient to be detected by eye, without measurement, and I had so noticed it before testing it by connecting the plans of the north triforium and clearstory stages by plumb lines at each end.

² Except in the easternmost bay (15, 17 a; 16, 18 a), where the clearstory window is practically central with the triforium arcade below, because on the east side the ogive springs from a shaft instead of from

a corbel. In the other half of this eastern double bay (13, 15 a; 14, 16 a), the centre of the clearstory window is about $7\frac{1}{2}$ inches to the east of the centre line of the triforium.

³ The centre lines of the triforium (τ) and clearstory (cc) are indicated for the bay 7, 9 a on fig. 8.

⁴ In plate xi, 2, white lines have been added to indicate the centre lines of triforium and clearstory.

These facts prove conclusively that the lunettes of the vault were set out before the clearstory stage was built. This relation of clearstory to vault is confirmed by the chevron string-course below the clearstory. In nearly every case the ends of this string-course finish with a complete chevron, which proves at least that the string-course was never cut to allow the vault to pass.

What has probably led, more than anything else, to the idea that the vault was an after-addition is the appearance of the lower parts of the ogives, from the corbels from which they spring to the clearstory string (plates x; xi, 1). It is clear that the stones were completely worked with the chevrons around the angles before they were set.¹ At their springings their profile only disengages itself from the wall to the extent of about the depth of the soffit roll, and the remaining depth is embedded in the wall.² It is probable that, as the walls were built, chases were left to receive the ogives, and that, when the walls had been carried up and the building of the vault was begun, the ogives were walled into these chases. However this may be, there is definite proof that the ogives were prepared for before the clearstory string was reached.

(3) If we are to accept the theory that the walls were built to receive a wood ceiling, we must eliminate the corbels and vault springings, which according to this theory must have been inserted later, and in the middle of each double bay there would be only a single spandrel of continuous walling between the two triforium arches. It is certain however that the two existing spandrels on either side of the springings can never have formed one continuous wall-face, for in some cases the bed-joints on the two sides do not range. The difference is quite perceptible to the eye in three cases, 11, 12, and 8 a. One of these (11 a) is illustrated in plate xii, 2, from a photograph on which the joints have been emphasized and continued by dotted lines. It is absolutely certain therefore that the vault was prepared for when the upper part of the triforium stage was built.

¹ This is evident from the edges of the chevrons which appear on the face. When the sides of some of the stones were exposed during the repairs of 1915, it was seen that the chevrons were worked on them behind the wall-face.

² In the north transept, where the edges of the ogives have plain hollows (plates vii and viii), it was possible to make a much neater joint with the wall-face than the serrated edges of the ogives permitted in the nave.



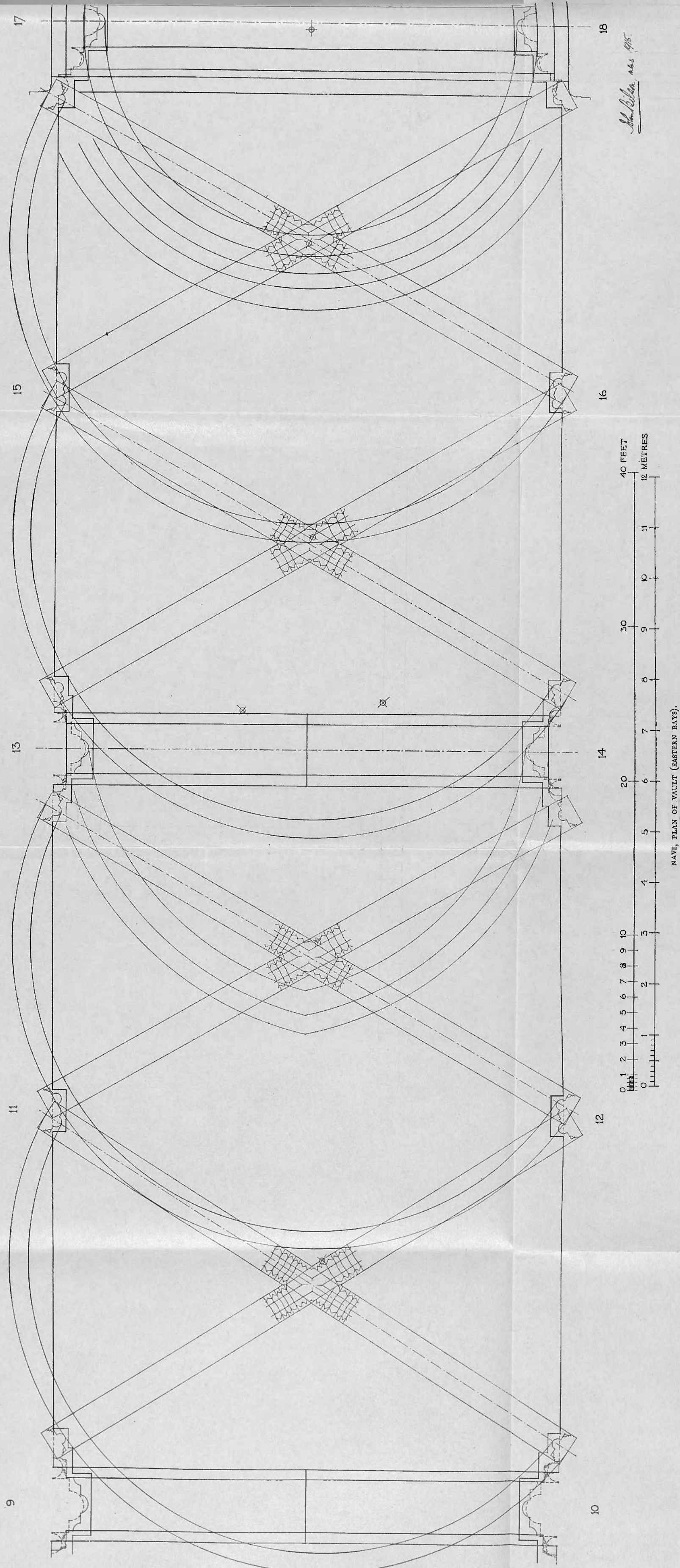
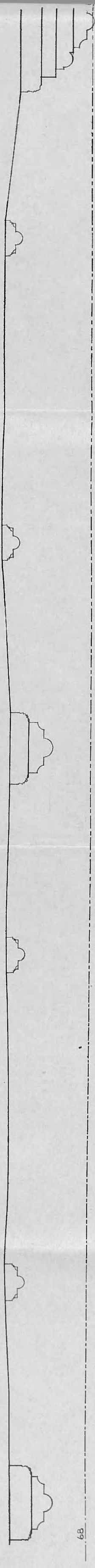
[R. J. Green, photo.]

I. NAVE, SPRINGING OF VAULT (7 a).

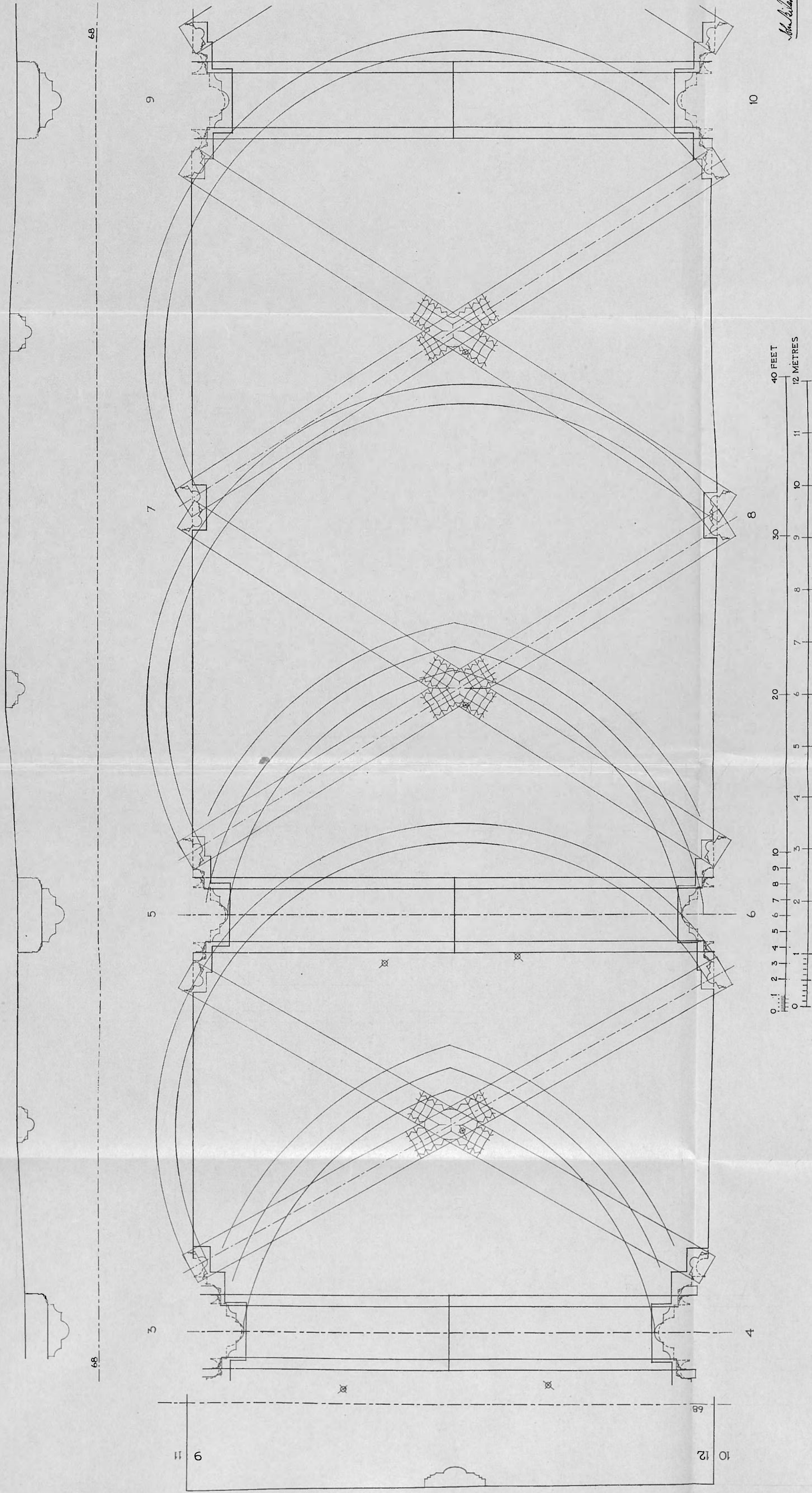


[R. J. Green, photo.]

2. NAVE, SPRINGING OF VAULT (II a).



NAVE, PLAN OF VAULT (EASTERN BAYS).



Tom Riley, Nov. 1915.

The three proofs set out above are confirmed by other considerations which have already been mentioned—the design of the clearstory arcade, its height in relation to the vault, the height of the clearstory wall-passage, and the preparation for the abutting arches over the triforium story. The conclusion is incontrovertible that the existing vault was built as the original covering of the nave.

Before describing the system and construction of the vault, it should be noted that the drawings (plates XIII and XIV)¹ are intended to represent the existing conditions of width and height.² The thrust of the vault has pushed out the walls, though to a much less extent than might have been expected from so heavy a vault had not the construction of the walls been so well and strongly designed. The average spread is under 5 inches, and the maximum about 7 inches, for the two sides.³ The arch curves set up on the plans,⁴ and the longitudinal and transverse sections at the crowns of the vault⁵ are drawn to the actual heights as measured. The original heights therefore may have been greater than those shown, within a limit of some 3 or 4 inches.

The vault of the nave springs, as elsewhere, from the same level as the crossing arches. The west arch of the crossing is semicircular, stilted about 5 inches, and its height governed to some extent the height of the vault. In addition to the three shafts which receive the principal orders of the crossing arches, the western piers of the crossing (17 a, 18 a) have (as elsewhere) an additional shaft designed to receive the outer order on the west side of the crossing arch. This shaft however was utilized for the springing of the ogives of the eastern bay, and the outer order of the crossing arch, which is decorated with chevrons,

¹ I have to acknowledge the assistance kindly given me by Mr. W. G. Footitt, of Durham, in taking measurements to complete my survey.

² The outer lines on each side of the plans (plates XIII and XIV) represent the wall-face immediately below the clearstory string. In order to avoid complicating the drawings, the set-back of the wall-face of the clearstory noted above (where it exists) is omitted.

³ The widths of the nave below the clearstory string were measured on each side of each bay, and the average of these fourteen widths shows an excess of just under

5 inches (4.82 ins.) over the average of the widths between the bases of the arcade piers. For plumbings of the walls of the nave, see *Proc. Soc. Antiq.* 2nd ser. xxviii, 51.

⁴ The dotted centre lines of the doubleaux and ogives on the plan, on which their curves are set up, represent the springing levels on the north side. Where the springing line on the south side varies from this (as it does to a slight extent in some cases), the south springing level is ignored.

⁵ These sections are drawn in relation to the dotted lines beneath them, which represent level lines 68 feet above the floor.

dies away into the cell of the vault some distance above its springing.

We have seen that, when the walls of the nave were being carried up, springer stones were set on the capitals of the great triple shafts which were designed for semicircular doubleaux, repeating the crossing arch. The doubleaux were however built as pointed arches, for the excellent practical reason that the pointed form avoided the weakness of the very flat crown of the semicircular arch over so wide a span. The apex of the extrados of the pointed doubleaux is only a few inches¹ higher than the crown of the extrados of the semicircular crossing arch. This gave a height which was more than sufficient for a semicircular arch,² but not nearly enough for a pointed arch of normal form. The arches were therefore made segmental, struck from centres some 2½ to 3 feet below the springing, adopting an expedient which had been commonly used for arches of similar height but varying span. The arches thus spring from the capitals at an abrupt angle, and their awkward form indicates that the builders were experimenting with a method which was new to them.³ The curve of the doubleaux is a little more obtuse than the *tiers-point*, except that of the westernmost (3, 4 a) where the span is less, the height about the same, and the arch consequently more sharply pointed.

The ogives of the eastern bay (15, 16, 17, 18 a) were set out as semicircles, very slightly stilted. The method shows a marked advance on previous practice.⁴ In the

¹ At 13, 14 a, the apex is 7 inches higher than the crown at 17, 18 a.

² At 13, 14 a and 9, 10 a, the height is about 17 inches more than half the span.

³ It has been suggested that the pointed form here is hardly consistent with the conclusion that the vault was built by 1133 (Lasteyrie, *L'architecture religieuse . . . romane*, 497, n. 1). It is true that the Norman school was slow in adopting the systematic use of the pointed arch, and that this is one of the earliest surviving examples in England. Nevertheless an example in the southern apsidal chapel at Gloucester shows how nearly they had approached the pointed arch before the end of the eleventh century (*Journ. R.I.B.A.* vi, 294 and fig. 5). Before 1133 it was in common use in other districts ('à partir de 1120 environ il commence à être systématiquement employé.' C. Enlart, *Manuel*, 320), and there is no reason why

the Durham builder should not have known it and used it in this tentative fashion. In 1128 the Cistercians made their first settlement in England, and in their earliest permanent churches they used the pointed arch much more systematically.

⁴ I take this opportunity of correcting a statement which I previously made, that in some later vaults, such as those of the chancels of the two churches at Devizes, the ogives describe a semi-elliptical curve (*Journ. R.I.B.A.* vi, 308). I have since remeasured these two vaults, and I am satisfied that the curves of their ogives, as originally built, were segments of circles struck from centres below the springing line. Distortion of the curves by settlement (especially marked at St. Mary's, Devizes) sometimes gives an erroneous impression. For an example of ogives of composite curve, see *Archaeological Journal*, lxxiv, 28.

earlier aisle vaults, and in the high vault of the north transept, we have seen that the geometrical structure of the vault was controlled by the semicircular curve of the doubleau, and the curve of the ogive was accommodated accordingly. Here the semicircular curve of the ogive becomes the dominant factor, and the system is an early experiment in the direction of the method which became normal when the use of the pointed arch was fully developed.

In the second bay (13, 14, 15, 16 a) the height from the springing to the key of the ogives is now 4 or 5 inches less than half the span, and in the third bay (11, 12, 13, 14 a) it is about 12 inches less. From this point (11, 12 a), the width of the bays being greater, and the height of the ogives practically the same, their curve is a little lower than a semicircle,¹ but not to any great extent, especially when the probable settlement of the crowns is taken into account.

As a consequence of this system of doubleau and ogive curves, the keys of the ogives are higher than the crowns of the doubleaux, and the crowns of the cells rise from the latter to the former, as shown on the longitudinal sections (plates XIII and XIV).² Transversely the crowns of the cells are nearly level. In the two eastern bays, the crowns rise very slightly from the north wall to the keys, and there is a rather greater rise from the south wall to the keys, as shown on the section at 13, 15-14, 16 (plate XIV). In the other bays westward, the crowns generally fall slightly from the north wall to the keys, and rise from the south wall to the keys.³ The reason of this difference between north and south is that the clearstory string on the south is everywhere a little lower than on the north,⁴ and, the height of the lunette being the same on both sides, the

¹ The difference between the height of the ogives from springing to key and half the span varies from about 12 inches to a maximum of 20 inches. In the single bay 3, 4, 5, 6 a, where the vault is narrower, the height is only about 7 inches less than half the span.

² As Professor C. H. Moore has called attention to this upward slope of the longitudinal crowns of the cells towards the keys of the ogives (*The Mediaeval Church Architecture of England*, p. 29 and fig. 22), it may be well to give the precise measurements which of course were not available when he wrote. The following represent

the height of the cell next the key of the ogive above the crown of the cell at the apex of the doubleau: 17, 18, west, 13 inches. 13, 14, east, 8 inches; west, 5 inches. 9, 10, east, 4 inches; west, 7 inches. 5, 6, east, 6 inches. These upward slopes are not of course consciously designed, but are simply the results of the system of doubleau and ogive curves.

³ The rise or fall nowhere reaches 6 inches, except in one case on the south side (6-8), where the rise is 10 inches.

⁴ The difference, very slight in the eastern bay, reaches 11 inches in the bay 5, 6, 7, 8.

crowns of the lunettes on the south are a little lower than those on the north.

I have already mentioned that the height of the clearstory stage of the nave, from the clearstory string to the crown of the lunette of the vault, is about 1 foot more than in the north transept. The transverse section of the vault at 13, 15-14, 16 (plate xiv) indicates that the height of the semicircular ogives must have governed the height of the crown of the lunettes, and this again fixes the height of the central arch of the clearstory arcade (fig. 8). The agreement of these heights can scarcely be mere coincidence, and it seems to me that we have here

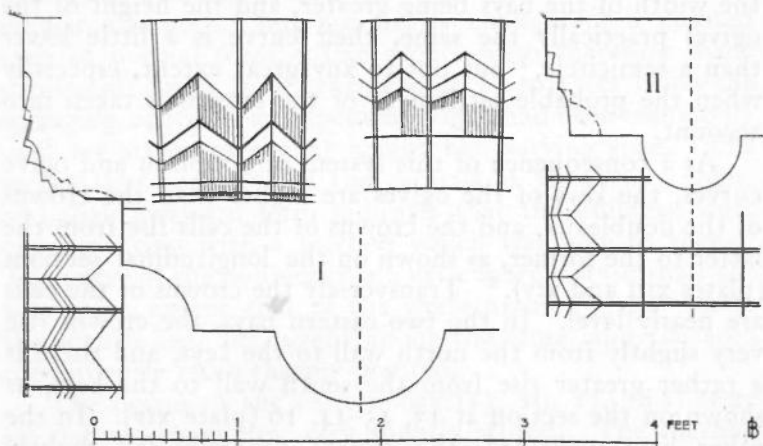


FIG. 9. DETAILS OF NAVE VAULT.

I, doubleau. II, ogive.

further confirmation of the conclusion that the vault was set out before the clearstory stage was built.

The doubleaux (fig. 9, I) have two orders; the inner order, which is more than 3 feet in width,¹ is moulded with a roll between two hollows, the same profile as the inner order of the crossing arches and of the doubleaux of the transept vaults; the outer order is ornamented with chevrons. The ogives (fig. 9, II) are moulded with a roll between two rows of chevrons. The doubleaux and ogives, like the arches generally, are constructed of thin stones, those of the ogives averaging something near 6 inches in thickness. The keys of the ogives are jointed in the same

¹ The widths vary from 3 ft. 3 ins. to 3 ft. 5 ins.

primitive fashion as those of the earlier vaults, the joints continuing the lines of the sides of the ribs, with stones of nearly triangular shape introduced next the key (plates XIII and XIV). All the keys have this lozenge shape, with the single exception of that of the bay 5, 6, 7, 8, where the joints of the key are at right angles to the direction of the rib (plate XIV).

The conformation of the cells is of course determined by the curves of the doubleaux, ogives, and lunettes, the cells having been built on straight boarded centering. The surface of the cells therefore always shows a straight line in what was the direction of the boards—generally the lines of the courses. Fig. 10 shows the horizontal sections through the springings at the level of the top of

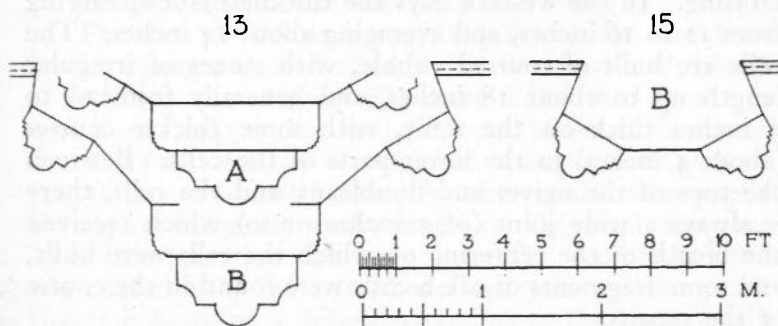


FIG. 10. NAVE VAULT, PLANS OF SPRINGINGS.

the clearstory string (A), and at 5 feet above (B). As the curve of the ogive is struck from a centre on (or near) the springing line, and the curve of the doubleau is struck from a centre considerably below the springing line, the surface of the cell on each side of the doubleau is not parallel with the wall, but at a considerable angle with it; consequently its surface twists as it rises, to the slight slope which it assumes at the crown.¹ The conformation of the lateral cells is controlled by the curves of the ogives and lunettes. As in the other early vaults, there is no wall-rib or wall-arch²; the curve of the lunette has the quasi-semi-elliptical form (fig. 8) which derives from the simple groined vault, but it is here an independent curve, which

¹ Shown by the longitudinal section on plate XIII.

² Except on the north wall of the north transept, where there is a wall-arch under the vault.

is not generated by projecting the curve of the groin perpendicularly to the wall. As the sections at B (fig. 10) show, the surface of the lower part of the cell forms an acute angle with the wall, and it gradually twists to the level line at the crown. The central cell between the ogives, in the middle of each double bay, is generated by their semicircular curve, and is therefore a barrel, the cross section of which is elliptical.

In the course of the repairs of 1915, when the plastering of the cells was stripped, it became possible to ascertain the thickness of the cells in certain places, and the manner of their construction. In the eastern bays their thickness may reach 20 inches or more. I measured it as 18 inches in three places in the second and third bays from the crossing. In the western bays the thickness is less, varying from 12 to 16 inches, and averaging about 14 inches. The cells are built of coursed rubble, with stones of irregular length up to about 18 inches, and generally from 2½ to 3 inches thick on the soffit, with some thicker courses (about 4 inches) in the lower parts of the cells. Between the tops of the ogives and doubleaux and the cells, there is always a wide joint (of 2 inches or so) which received the boards of the centering on which the cells were built, and some fragments of oak boards were found in the course of the repairs.

An interesting point was revealed with regard to the coursing of the masonry of the central cells on either side of the doubleaux. This was best seen in the cells illustrated by plate xv. In the cell on the east side of the doubleau 5-6, the courses work out obliquely at the crown, the joints from the apex of the doubleau diverging about 18 inches each way, to about 3 feet apart next the key of the ogives. The same method is distinctly shown in the cell to the west of the doubleau 9-10. In the other cells¹ (including that to the west of 5-6), the coursing is more irregular, especially on each side of 13-14, but the courses in all tend to work out obliquely at the crowns. This result arose quite naturally from building each course in the ordinary way with stones of the same width. It is an interesting anticipation of what is often called, in too general terms, the

¹ The plaster was not stripped from the cells in the eastern bay.

'English' method of jointing worked cells.¹ The lateral cells are generally built in courses roughly parallel with the axis, but in one or two cases some obliquity at the crown was noticed.² The central cells in the middle of each double bay are coursed normally as barrels.

Another point in the construction of the central cells may be worth recording. The lower courses of these cells are not built with radiating joints, but with horizontal beds, corbel-fashion. In the springings of the cell on each side of the doubleau 13 on the north and 14 on the south, these horizontally bedded courses extend to a height of from 5 to 6 feet above the top of the clearstory string. In the springings of the cell in the middle of the double bay at 11 and 12, the courses are bedded horizontally up to about 7½ feet above the clearstory string.³

The date of the nave vault remains to be considered. In the passages quoted above,⁴ the continuator of Symeon records (1) that bishop Flambard built the nave *usque testudinem*, and (2) that in the interval between Flambard's death (1128) and the accession of bishop Geoffrey Rufus (1133) the nave was finished by the monks, who applied themselves diligently to the work—i.e. they built the vault. This interpretation has been generally accepted, but it was contested by the late M. de Lasteyrie⁵ on the ground that it is based on a misunderstanding of the true meaning of the text (1). He said that the word *testudo* had been translated by *vault* without regard to the fact that in the Latin of the twelfth century it is a generic term which simply means *couverture*, to which the adjective *lapidea* was added when it was desired to give it the specific meaning of *vault*.⁶ While it may be admitted that *testudo* was

¹ Viollet-le-Duc, *Dictionnaire*, ix, 522. Many important examples in England however follow what is generally called the 'French' method, and the earliest example of the so-called 'English' method which I have seen in worked cells is in France—in the straight bay of the choir of Morienval (Oise).

² At 14–16, seven courses at the wall run out to a single course at the crown towards the key of the ogives. Something of the same kind could be seen at 7–9 (plate xv).

³ At the springings in the middle of the double bays, the backs of the ogives only clear themselves, and the cells begin, at some little height above the clearstory string.

⁴ p. 103, n. 4 above.

⁵ *L'architecture religieuse . . . romane*, 497, n. 1.

⁶ 'Il est probable qu'on n'aurait jamais songé à les' (i.e. the vaults of the nave) 'croire antérieures à 1133, si on ne s'était mépris sur la véritable signification du texte ou on a cru en trouver la date. . . . On a traduit le mot *testudo* par voute sans prendre garde que dans le latin du xii^e siècle, c'est un terme générique qui signifie simplement couverture. Quand on veut lui donner le sens spécifique de voute, on lui adjoint l'épithète *lapidea*. On en trouve la preuve dans le *Recueil de textes* de Victor Mortet.' *L'architecture religieuse . . . gothique*, 31, n. 4.

a generic term for *couverture*, it by no means follows that it was not used for a stone vault without the addition of *lapidea*.¹ Indeed we have a very definite example to the contrary in the passage from William of Malmesbury's *Gesta Pontificum* quoted above,² where *testudo* without any adjective is used for a stone vault built on wooden centering.³ The translation of *usque testudinem* in the first passage by 'up to the vault' is therefore possible, though on textual grounds alone it is not certain. But when the two passages are read together in the light of the evidence of the building, there can be no possible doubt as to their meaning. It is quite immaterial whether *testudo* here is translated roof, or ceiling, or vault, in view of the interdependence of clearstory and vault which has been demonstrated above. If Flambard carried up the walls of the nave to the roof, it is certain that the works to which the monks diligently applied themselves in the five years following his death included the vault for which complete preparation had been made in the upper parts of the walls, and without which the nave could certainly not have been described as finished.⁴

If further proof be required that the nave vault was built by 1133, it is fortunately to be found at Durham itself in the building which immediately followed the completion of the nave. The chapter-house is recorded to have been finished during the episcopate of Geoffrey Rufus (1133-1140).⁵ It was partly destroyed in 1796, and rebuilt on the old lines in 1895. An accurate record of it

¹ The instances of *testudo lapidea* in Mortet, which M. de Lasteyrie mentioned, are far too few to prove his point. Was it by inadvertence that Mortet indexed the Durham passage (1) under *testudo lapidea*?

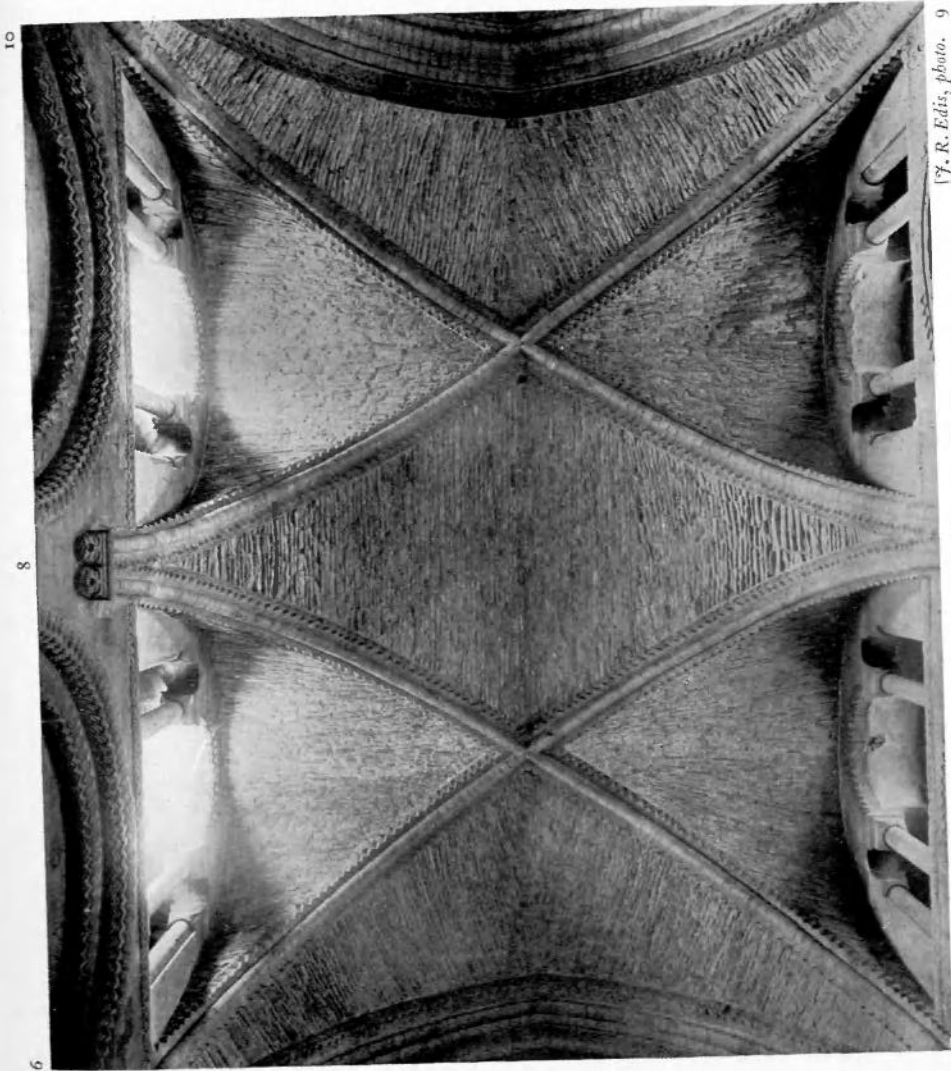
² p. 124, n. 1 above.

³ This passage is cited by M. de Lasteyrie on the same page as his note quoted above, and he himself translates *testudo* by *voûte*, and speaks of it being *decintres*.

⁴ I do not wish to lengthen this paper unduly by discussing other churches, but it is worth notice that the acceptance of the theory that the Durham vaults represent alterations or after-additions would involve very serious difficulty with regard to the chronology of the churches of Lindisfarne and Dunfermline, which were closely inspired by Durham in its present condition. At Dunfermline the vault of the north

aisle has the same system and the same profiles of doubleaux and ogives as the aisle vaults of the choir and transept of Durham. A similar observation applies to the aisle vaults at Lindisfarne, which moreover was a completely vaulted church. The nave arcades imitate imperfectly the alternate system of Durham, but the functional difference between the clustered and cylindrical piers is missed. In the vaults of the choir, transept, and crossing, the corbel motive is copied, without regard to its introduction as a makeshift at Durham. If the Durham vaults have been altered, reconstructed, or inserted at some later date, obviously the builders of Lindisfarne and Dunfermline can only have copied them after they had assumed their present form.

⁵ 'Ipsius tempore capitulum monachorum consummatum est.' *Symeon*, i, 142.



[J. R. Edis, photo. 9]

NAVE VAULT, BEFORE RE-PLASTERING (5-9 a, 6-10 a).

is preserved in John Carter's drawings,¹ and beside the original portions that have survived or have been incorporated in the new work, a considerable number of its old stones still exist. All show details which are decidedly in advance of the upper parts of the nave. It was vaulted in two bays, with semicircular doubleaux, of the normal quadripartite plan, and not the less developed form, without doubleau in the centre of the double bay of the transept and nave vaults. The apse was vaulted in five bays.² The ogives of the apse vault have a soffit roll flanked by a row of star ornament sunk in a flat face, and on each side of the rib are sunk chevrons profiled with a flat roll and quirked hollow³, of more advanced type than any of the chevron ornamentation in the nave. The ogives of the quadripartite bays show a soffit roll flanked by chevrons of convex profile, as in the nave, but the detail is more refined, and the soffit roll is slightly pointed or keel-shaped.³ This last detail is a conclusive proof that the vault is of later date than the vault of the nave.⁴

It is therefore certain that the vault of the nave was built by the monks between 1128 and 1133.

To sum up. The story of this great church, the noblest monument of the Norman Romanesque, shows an orderly sequence from its beginning in 1093, broken only by one departure of importance from the essential character of the original scheme. It was planned by a master of exceptional ability as a completely vaulted church, and its earliest ribbed vaults, over the eastern bays of the choir aisles, must have been built by 1096. The whole of the eastern arm, together with the eastern side of the transept as far as the top of the triforium, was completed in accordance with the conception of the first master. The diminished resources at the disposal of the monks after bishop William's death in 1096 did not prevent their completing the choir with its vault by 1104, but seem

¹ *Some account of the cathedral church of Durham*, with drawings by John Carter, published by the Society of Antiquaries, 1801 (details in plate xi). See also two drawings by Carter reproduced in *Trans. Durham and Northumberland Arch. Soc.* v, pp. 31-32, plates II and III; and internal view in *Billings*, pl. 52. For a reproduction of Carter's plan, see *Rites of Durham*, ed. Fowler (Surtees Soc. 107).

² *Journ. R.I.B.A.* vi, 318.

³ *Ibid.* vi, 346-7 (details and photograph). For a drawing of the key of the apse vault, see *Trans. D. and N. Soc.* v, 33.

⁴ The chronological sequence of the vaults as indicated by their details is discussed in *Journ. R.I.B.A.* vi, 347 (with illustrations), and ix, 353.

to have led eventually to the abandonment of the original intention of vaulting the transept. In the south transept the clearstory was built for and received a wood ceiling, instead of the vault, apparently much about the same time that the choir was finished. In this modification of the original scheme, no provision for receiving the members of the high vault was made in the triforium stage of the west side of the transept, or in that of the eastern bay of the nave which formed part of the same build. We may well imagine that one result of the great translation of 1104 would be such a substantial increase in the resources available for building as to justify a return to the original plan by the building of the high vault over the north transept, which was finished somewhere about 1110. When about the same time the works of the nave were resumed, its builders continued the modified triforium of the eastern bay which had been built with the transept, without vaulting shafts, but they set out the upper parts of the walls to receive the vault, with which the nave was finished between 1128 and 1133. While the nave was being built, the wood ceiling of the south transept was replaced by the existing vault. Thus during the forty years from its beginning, every part of this great church¹ was covered with the ribbed vaulting for which its first master had planned it.

It remains for me to express my thanks for permission to reproduce their photographs to those whose names appear on each, viz. to Messrs. F. H. Crossley, F.S.A. of Chester; J. R. Edis, of Durham; R. J. Green, of Durham; C. C. Hodges; and J. V. Saunders, M.A. I have also to thank the *Société française d'archéologie* for kind permission to reproduce the photographs by the late M. Eugène Lefèvre-Pontalis, which will have an added interest for some of our members from the fact that the photographs were taken by him when he attended the meeting of the Institute at Durham in 1908.

¹ With the possible exception of the crossing (see above).