and parapet walls. The outer walls for the sized arches we have assumed should be about three feet thick, and con­structed with bricks laid in horizontal courses, properly jointed with the arch quoins. The interior walls should be eighteen inches thick.

A string course should be laid along the whole length of each front of the viaduct, projecting uniformly with the face line of the arches. No stone in this string course should be less than three feet six inches in length, neatly tooled on the exterior, with the joints made to fit close for the whole bed of the stone. The parapet walls will have a bolder and handsomer appearance, if they stand on a stone plinth, about eighteen inches high, and eight inches wide, placed upon the string course ; the remaining portion of the wall being brickwork, fourteen inches thick ; the courses being carefully laid parallel with picked bricks ; the exterior faces of the plinth being fair tooled, and the whole of the walls throughout forming a uniform and regu­lar line.

The coping should be of stone, the form and dimensions for which should be shown in the drawing ; and no stone should be less than three feet in length, neatly jointed, and the exterior faces fair tooled or chisel-dressed, each stone being dowelled or leaded to the adjoining one. The spaces round the footings of the abutments and wing walls should be firmly rammed up with clay, if it can be procured, to the level of the ground, in courses of one foot in thickness, each layer being properly beaten before a succeeding one is put on. It will sometimes be convenient to make a new channel for water-courses, so as to bring them through a given arch of the viaduct. In this case, the old channel should not in any way be impeded, till the new channel is formed ; after which, the excavation which has been taken out to form the new channel, may be used in filling up the old.

Great care should be taken in the selection of materials for the construction of these works. The bricks should be hard, sound, and well burnt ; those used in the face of the work being selected of a uniform size and colour. The quar­ries from which the stone is to be brought, should be nam­ed, and care taken that the whole is of a good and hard quality, free from flaws of every description. The mortar should be made of lime to be named in the specification, and mixed in the manner, and in the proportions between the lime and the sand, which is known to be best for the particular kind of lime, and be thoroughly incorporated of the proper consistence. The Roman cement should be re­cently made, and kept from contact with the atmosphere, or any moisture. An equal quantity of good sand or road dust should be mixed with it ; and no more than what is required for immediate use should be mixed, or any that has set be worked up again.

The brickwork should be laid either in English or Fle­mish band, as may be ordered ; and in no case should any joint of mortar exceed a quarter of an inch in thickness ; no broken bricks should be allowed to be used, either in­ternally or externally, unless absolutely necessary as clos­ers ; nor should any difference be made in the exterior and interior *of* the work. The whole of the brickwork should be grouted at every course, and the exterior neatly point­ed. All the stonework should be truly bedded, and the vertical joints cut square back for the whole bed of the stone ; no pinning of any kind being allowed.

After the piers have all been brought up to the level of the springing of the arches, the contractor should fix the centering, and complete the brickwork and masonry of the three arches, and their backing next adjoining to an abut­ment ; the wing walls and spandril walls being also carried up to the same height as the backing. When these three arches have all been completed, and properly backed, the centering may be removed from the arch nearest the abut­ment, and fixed in the proper place for the completion of the fourth arch. As soon as the fourth arch is completed, ' and backed as above, and not before, the centering may be moved from the second arch from the abutment, and fixed in the proper situation for completing the fifth arch ; and so on with the rest, the centering never being removed from the two last arches which have been turned, until a third, or the one in advance of these two, has been finished. The centering used should be subject to the approval of the engineer.

The string course, plinth, parapet walls, and coping, should not be put on, until the whole of the centres have been withdrawn ; and in no case should the centering be struck without orders from the engineer. If the founda­tions require cofferdams, the contractor should be bound to find them at his own expense. Great care should be taken that the viaduct is properly placed, so that, in the case of a railway, the outside line of rails, when laid in their uniform and proper position, shall be equidistant from, and parallel with the faces of the parapet walls ; and in case the line in that particular part where the viaduct is, should be curved, this will require the most vigilant attention ; also, that be­fore the string course is laid on, every part of the brick­work is properly level, so that the eye, in running along the string course, shall not be able to detect any deviation from the given line. We have known more than one case in which a noble and handsome structure has been entirely defaced, to a professional eye, through the inattention or the incapacity of overlookers who have been entrusted with this important part of the work.

After the expense of an embankment equals that of a viaduct, there will almost always be a gain in building the latter, if an increased height is required ; because the ad­dition to the piers and abutments for this extra height, will cost much less than the additional earthwork at the base of the embankment. Let us take a case in point. In 250 yards of railway, forty-five feet high, there are required three bridges. A viaduct for this 250 yards, with fifty feet arches, would cost L.17,000 ; each bridge would cost L.1400, and the remaining embankment sloping 2:1, would cost L.6150, at ls. per yard ; total, L.10,650. Hence the viaduct is much the dearest method. If the height was seventy-five feet, the bridges may be taken at L.2000 each, and the remaining embankment at L.15,250; total, L.21,250, besides the extra land ; while the viaduct, hav­ing only 216 cubic yards of brickwork, at L.1 for each yard additional height, after full allowance for extending the wing walls, &c., would only cost L.19,000. We may conclude, therefore, that viaducts are cheapest only at very great heights. Much of course depends on the length of lead, whether building stone can be got from an adjacent cutting, &c. The cost may however be lessened, by a judicious use of wood and iron. Several wooden viaducts have lately been constructed for railways; and in America they are largely used. A novel plan has been adopted in that country by Mr Town. (See Stephenson’s Civil En­gineering of North America.)

In the preceding articles in this work, the subject of arches has been so fully discussed, that nothing remains ex­cept to give a guide to practical men, how to construct the arch of equilibrium, and to shew the variation which it under­goes under different dimensions. Supposing, then, the road­way on the viaduct to be horizontal, (fig. 1, Plate CCCCC.) let KI = *y,* AQ = A, CI = *w,* DK = *a,* and KQ =: C, then

*\*\*\*\*\*\*a*

Log. of re -J- *λJ wi—~a"i*

y ~ ALog.ofc + ιv∕c2-gs

*a*

where the denominator has only to be computed once, and