Bridge of the Month No92, August2018
Bridge 74A Leeds and Liverpool Canal

What is special about a simple canal bridge? It doesn't really look very special in the photo below.

The bridge number, 74A, makes it clear that this was added after the canal was complete. It is here in the edge of Chorley carrying the West Coast Main Line over the Leeds and Liverpool canal.

What we can see here is that the arch is highly skewed and that the basic shape is perhaps elliptical or three centred on the square. Three centred is more common over canals because it gives better headroom for a horse and leader on the towpath. Because it is so skew, and because it was built to carry the railway over the canal and is therefore a one-off, it is most likely that the centres were set on the skew. As we will see, the complexities of that geometry are trivial compared with other aspects of this bridge.

I have read many times about the so-called French coursing system for skew arches. I suspect that the French epithet came from the masons who might well have had cause to say "scuse my French" when building it. I first found a bridge of this pattern near home in Exeter but there it was built in brick. But let's get past the tease stage and look at the ring face.

This view of the acute corner shows well what I mean about complexity. A little bit of careful observation shows that the beds all meet the edge at right angles.

A closer look is worthwhile.

If you look closely you will see how the stones repeat. And they also mirror, of course. So there are actually a lot of identical stones to cut. On the other hand, this would be very difficult in really hard stone and I suspect the masons would have worked the stone green for this job. Sandstone newly exposed is very much softer to work than when left to dry so it needs to be worked as quickly as possible. If the quarry wasn't local, these stones would have been shaped before transport. Perhaps a quick highlight will help.

What I find most interesting about this is the apparent belief that:

1) The force flow was definitely on the skew
2) It was important that the beds crossed the flow of force at right angles.

The first of these may be broadly true (certainly closer than the equally firmly held modern belief that the arch spans square except at the edge) but if we consider half the arch as a free body, there must be considerable shear at the crown to direct the thrust on the skew and that shear must react somewhere. If at the skewback, the straight horizontal line becomes an obvious place for failure.

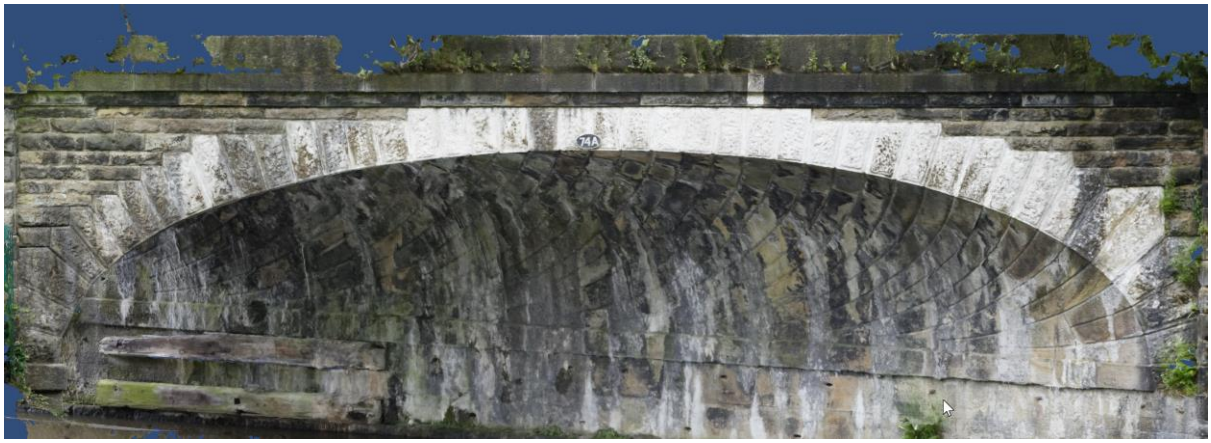
The actual flow of force creates some very interesting effects. My visit was planned but short so I concentrated on getting photos for a 3D model to look at later. Just before I left I noticed this area.

This is the obtuse corner of the arch above the towpath. The picture is squint to get in the maximum amount of detail for modelling. Notice how the smallest stone in the spandrel is completely free. There is no sign of mortar anywhere round it. The open joint seems to continue down but not up the pilaster though there is some later filling of that joint further down. The joint between wall and ring is open as far as this photo reaches, though once again there has been cement mortar patching near the top. And several other spandrel stones are clearly working loose.

All this is telling us something important about the way skew arches behave. Next problem is to work out just exactly what it is telling us!

But back to the details of construction The tinted picture above shows the degree of repetition possible. Not as much, though, as in a helical bridge where if they are all the same length, any stone can go anywhere. To make these complex stones, the engineers had to design templates to help the mason's cutting. I have detailed instructions for such templates for a helical bridge.

Another feature which is true for both styles is the need to decide on which alignment the Radial edges of the stones should be square to the intrados. Given the reason for complication it seems that it should be on the skew line, whereas in a helical arch the stones become progressively more lozenged along the skew edge (below).



The 3D model makes it possible (in our own viewer) to get an ortho-photo of the spandrel which reveals some interesting things. If you wish to explore the model in lower resolution it is here. Note first how different the stepping on the Voussoir tops is left to right. Unfortunately, the skew meant that the photos ran out on the other edge so I can't make a direct comparison but certainly the right hand end repeats. This narrow shot is the best I have and explains why the model falls apart in this area. If I get there again I will leave time to cross the canal and fill in the details.

This closer view suggests that the joints are intended to be square to the intrados but lean a little around the quarter span.

I will continue my search for setting out details and report here when I find them.