

Bill Harvey Bill Harvey Associates Ltd and OBVIS Ltd

I came across Pynes Bridge (<http://g.co/maps/4knwa>) quite by accident. It is under the road and over a small river so it is hardly noticeable. But it was a sunny day and I saw the parapets and there was a place to stop.



These are some of the flattest parapets I have seen. A sign of a very robust bridge. The stone copings finish it well. I have never before seen a parapet with a stepped inside face. I think the lower step, just above the pavement, is the inside edge of a stone string course which appears on the outside.

I have often stopped at bridges, but I don't think I have ever been so surprised by what they have to teach me as when I stopped here.



In this shot you can see that the bridge is skewed but the more important issue is the piers. Each pier is four columns of granite. Above that are cast iron shoes providing a base on which to build the arch skewbacks.



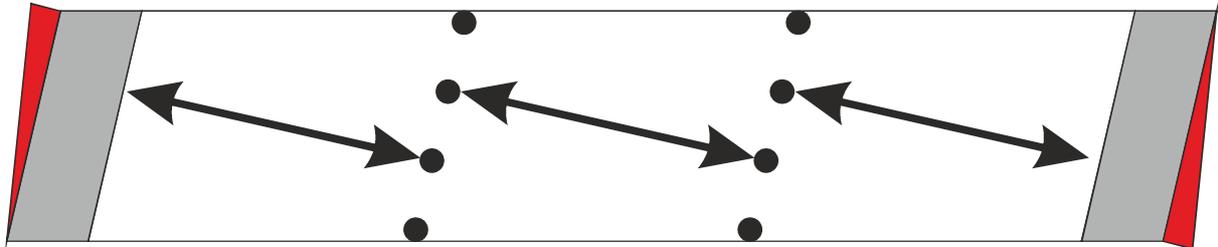
Look more closely and you will see that the skewback is actually made of stone, or possibly concrete, sitting on the cast iron shoe.



You can see, here, how the shoes divide in the middle of the piers. Any joints in the stone are well disguised. Indeed, it was only on closer examination of these photographs that I detected the illusion created by marking up brick shapes on the stone face. A closer look, below, shows how the cap stone of the pier column has split. It also shows the change from real to drawn bricks. That is even more visible on the further pier.

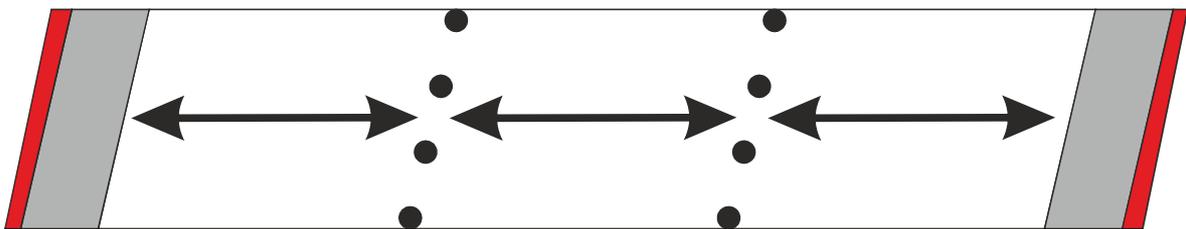


But none of that is the reason for showing this bridge. The important thing is what it has to teach us about skew arch behaviour. The established view is that skew bridges try to span square. Even if that is true, the centre of thrust at mid span must be at the centre of the bridge width. Drawing that effect shows that the resulting forces on the piers create a substantial moment in plan (below).



It does not take fancy analysis to realise that this wont work. The moment has to be taken out by the piers and these piers very obviously have negligible resistance to moment.

Actually there is more to it than that. Having had the insight from the piers, it is good to think about the abutments. Are they stiff enough to generate the thrust distribution shown. In the plan direction the arches are very stiff indeed. It is quite unlikely that the abutment can deliver similar stiffness, so the abutments will give and release the skew as below.



Look back to last months note and you will see that William Froude was sure that these arches spanned on the skew. Froude was not alone, throughout the 19th century engineers assumed that the bridges spanned on the skew. So how did the prevalent idea of square spanning develop?

It is certainly true that skew slab bridges try to span square. That is evidenced by cracking of real slabs and by analysis. Analysis of skew slabs is relatively easy because the torsional stiffness of the slab is very much less than the vertical stiffness of the abutments. Treating the abutments as rigid yields results that are certainly good enough for design. In arches, the important direction is horizontal and the stiffness of the abutments is lower than that of the arch. Treating the abutments as rigid is a serious mistake and will give results that are dramatically wrong.

A few more pictures to finish





The join between the stone skewback and brick arch is very visible here.

## News

### Local Talks

Bill will be speaking in Cork on 20th October.

Bridge Management and Maintenance: Bill is convenor of the Study Group at IStructE. It is open to anyone with an interest in bridges. Ideas for meetings are always welcome. We are trying to set up a discussion group and also a meeting to discuss preparation for and response to floods and issues of mechanical parts of bridges (eg bearings and expansion joints. Contact [Sarah.Okoye@istructe.org](mailto:Sarah.Okoye@istructe.org) to join or [bill@obvis.com](mailto:bill@obvis.com) with any ideas or offers of assistance.

Archie-M The latest version of can be downloaded from: <http://bit.ly/BillH5>

Seminars and courses. Courses are run as a profit making concern by Bill Harvey Associates and need take £3000 to cover the costs so say 10 people at £300 each. The standard charge for Seminars, run as part of the support for Archie-M is £100 which is intended to cover costs only.

If you would like us to run a course (a full day intensive training) or a seminar (intended as an update on arch studies and Archie plus discussion between users) near you, please let [Philip@obvis.com](mailto:Philip@obvis.com) know.

Continuing thoughts about arches and Archie at <http://billharvey.typepad.com>

Moiré Tell Tales: High sensitivity, long range reading. <http://bit.ly/BillH6>