Bridge of the Month No8 August 2011
Cowley Junction, Exeter

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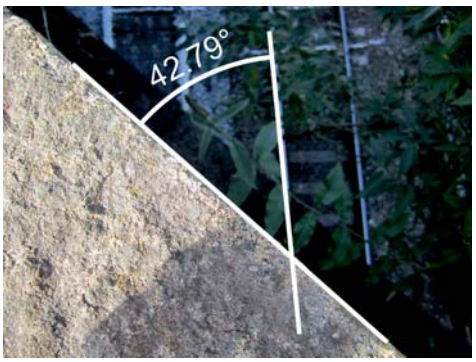
The second of our skew bridges is at Cowley Junction (http://bit.ly/cowleyjunction) in Exeter. It has the distinction of having been designed by one William Froude. Engineers will be familiar with his work on ship modelling but he began with Brunel as engineer on the final stages of the Bristol to Exeter extension of the GWR. The reason for including a modest railway bridge here is that it tells us a great deal about what mid 19th century engineers thought about the way skew bridges worked.

This is a skew bridge, and the first thing to note is that it presents an almost semi-elliptical form when viewed square to the spandrel. A track aligned view is, of course, not possible from accessible places but I am confident from the plotting I have done that the bridge is a semi circle on the square span.

The apparent shape is compounded by the fact that the spandrels have a gentle curve in plan and are also sloped back slightly in elevation (see next page). Froude was clearly determined to stiffen the spandrels as much as possible against the spreading effects of the fill.



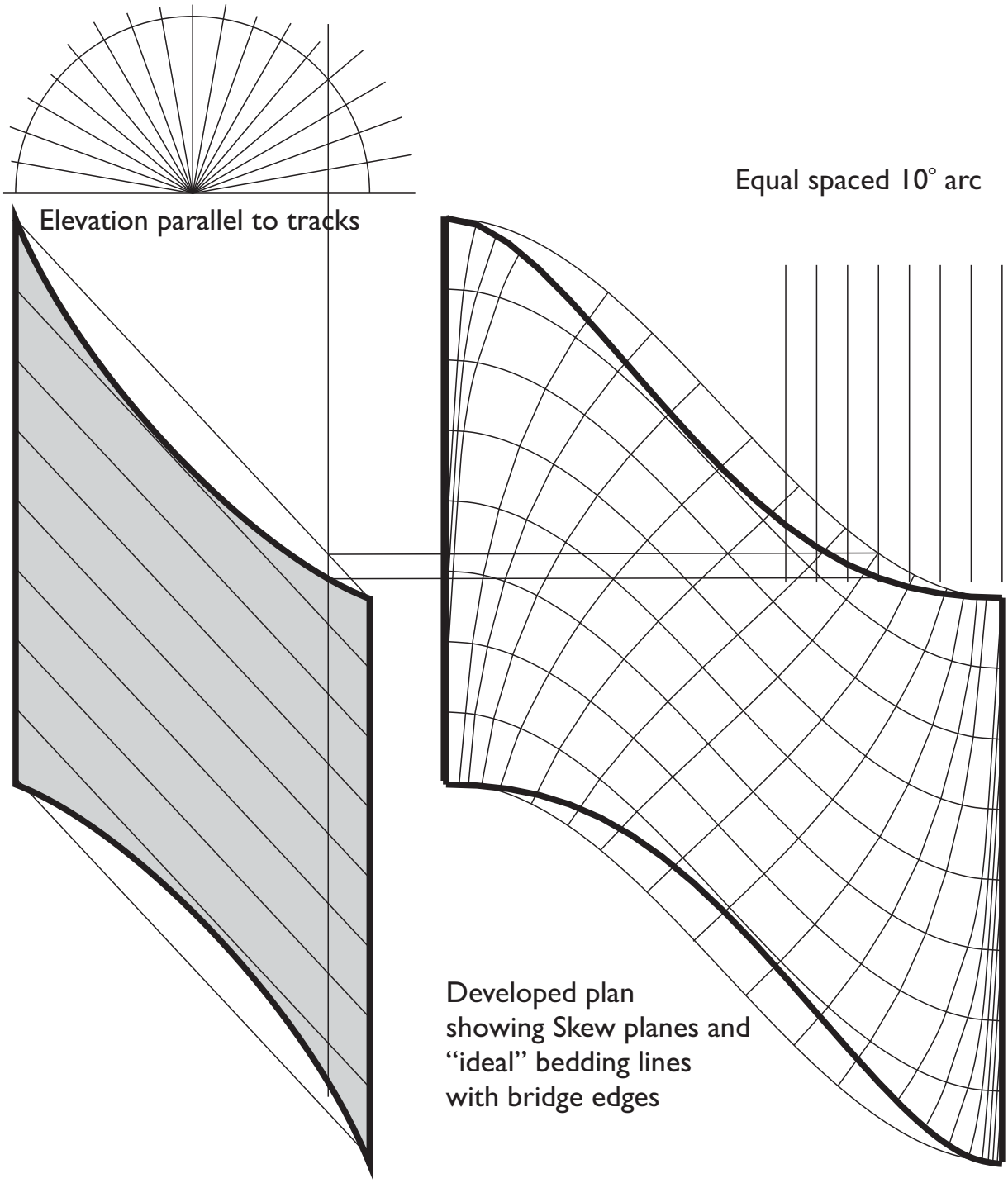
The degree of skew is clear from the detailed plan view taken at the crown. This shows the relative alignment of the parapet and the track.

This view shows the curve and tilt of the spandrel wall. It is interesting to note that the string course, the coping and the brick courses of the parapet all follow the same curve. That must have been difficult to build.

The courses lower in the spandrel also have a slope to them which certainly looks better than the usual accidental droop.

This view of the soffit of the bridge shows why it is so interesting. Look carefully and you will see that the brick courses are tapered and swept in a very complex fashion.
Perhaps it is worth looking a little closer.

My first reaction on seeing this is that the bricklayers must have loved Mr Froude! They have actually largely failed to follow the strict pattern which was Froude's target, but to explain that it will be necessary to resort to drawing a developed shape, somethng I haven't tried for 40 years.



The drawing above follows a scheme of projection published in GW Buck "Oblique Bridges" which was a standard handbook for much of the 19th Century. It begins with the semi-circular elevation top right, which is divided into equal angles. The divisions are projected down the page into the plan view on which are drawn a set of parallel skew lines. To the right of the plan is the developed (unwrapped) view. Calculation is involved here because we need a net of vertical lines equally spaced at the arc length of the divisions in the original elevation. Projecting across from the skew lines to these verticals produces the S shaped lines that slope down from left to right. The bedding lines are then drawn so they cross these S lines at right angles.

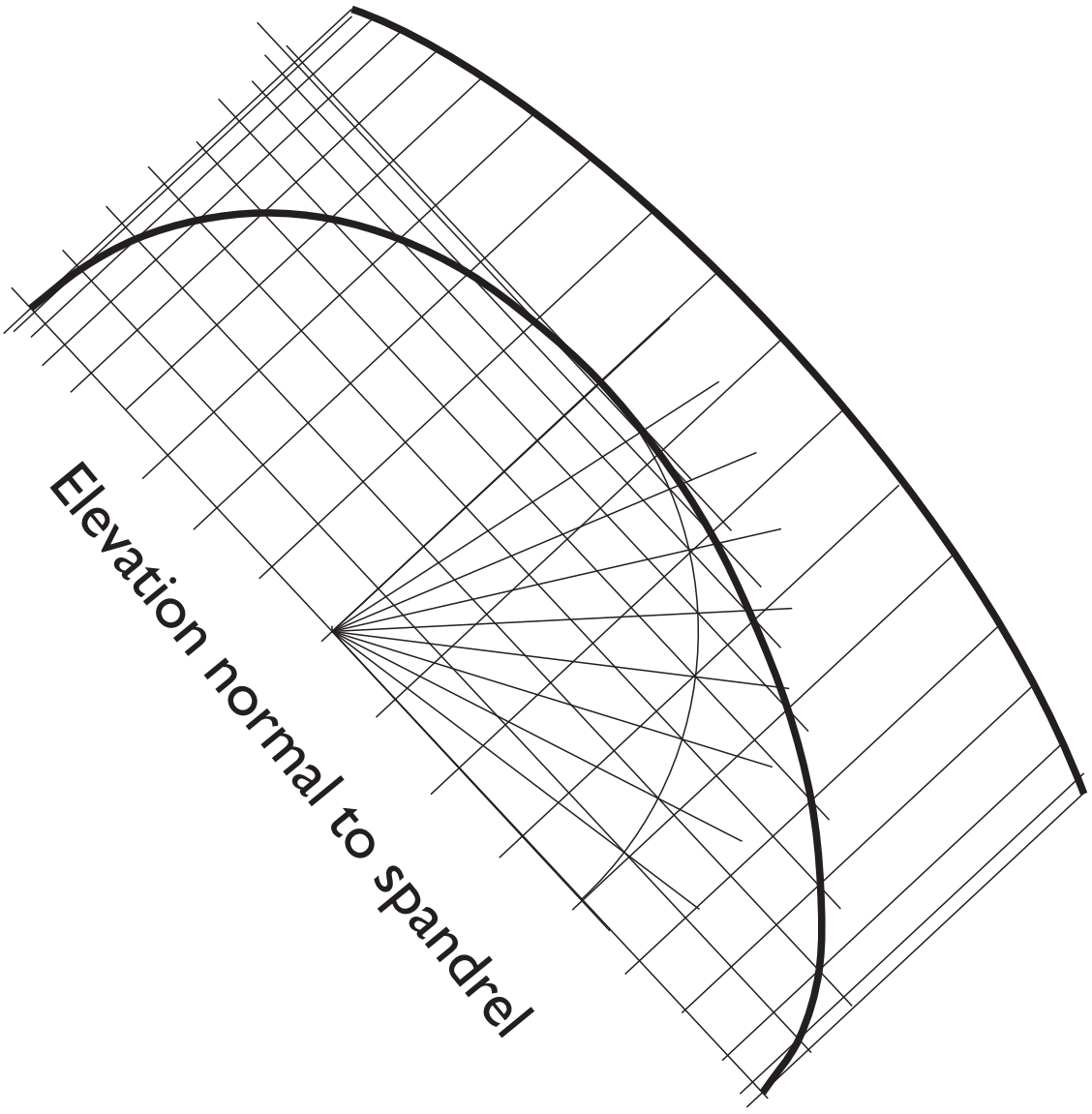
So why go to such lengths? Froude, and many other engineers, firmly believed that the thrust in a skew arch flows on the skew line. The S shapes in the developed plan are those skew lines. The beds are then set normal to the skew line so that thrust crosses the beds at right angles.

That raises two major questions:
1) were the 19thC engineers right about the flow of thrust and
2) is it necessary to have the beds normal to the thrust anyway.

It is often said that skew bridges try to span square. Next month's bridge will raise real questions about that.

Last month's finished with a picture of a skew arch with beds parallel to the abutments.

Look again at the first photograph. The shape looks rather strange. The profile seems to be slightly stretched to the right. The projection below shows why. It fits bottom left on the previous page.



News

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 to join or 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 know.

Continuing thoughts about arches and Archie at http://billharvey.typepad.com
Moiré Tell Tales: High sensitivity, long range reading. http://bit.ly/BillH6