Bridge of the Month, December 2013
Bridge Centring

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As with all previous Bridges of the Month, a pdf copy can be downloaded from the OBVIS web site.

News and Events
Follow Bill on Twitter @BillHarvey2

Archie-M
We are working hard on two new versions. The first will have a number of relatively modest changes, but will include taking the backing into the arch to provide better "AutoRun" results. The next step is a much more robust treatment of multi spans and a new distribution model which will eventually make it possible to deliver a rational analysis of skew bridges.

New understanding of Multi span action to be written up for publication soon.

Seminars and Lectures
Hertford County Council Offices 29th Jan 2014 Postponed due to lack of numbers. Please let us know if you would be interested.
MottMacdonald Altrincham office early 2014

Please contact Philip@obvis.com if you are interested in attending a day seminar on Arches and Archie. The program for this year includes:
Bill's recent work (some interesting bridges!)
Skew Arches
Ring separation
Causes of live load damage
We charge £100 for the day but if you wish to host a session at your office we then wave the charge.

Recent Publications
Bill's paper about the effect of stiff spandrel walls judged best in Bridge, tunnels and geotechnics at ICE: **Stiffness and damage in masonry bridges**. Proceedings of the Institution of Civil Engineers, Bridge Engineering 165 September 2012 Issue BE3 Paper 1100032 Pages 127–134 http://dx.doi.org/10.1680/bren.11.00032

A spatial view of the flow of force in masonry bridges, Proceedings of the Institution of Civil Engineers, Bridge Engineering 000 Month 2012 Issue BE000, Paper 1100026, Pages 1–8 http://dx.doi.org/10.1680/bren.11.00026
Sutherland History Lecture 2012 at http://bit.ly/J4gblz

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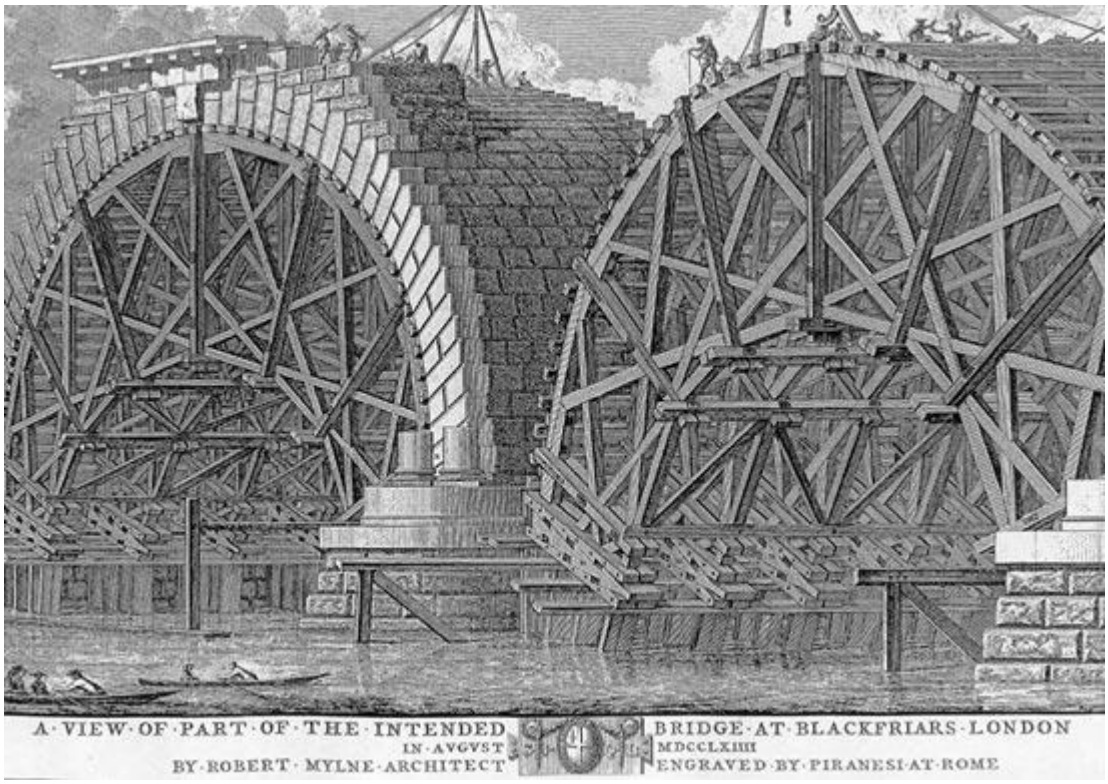
A new year provides the opportunity to do something new. I have long been fascinated by the way these bridges were built and some recent communications have fired up the interest. One of the big differences between bridges and buildings has always been the need to build a temporary bridge to carry the permanent one while it is built. These bridges must be fiercely engineered for economy, but they are rarely recorded and leave little in the way of archaeology. Luckily, the engineers were often rightly proud of their centring and there are a number of volumes containing etched images of drawings. This month's note was prompted by an email from my friend Adrienn Tomor of UWE in Bristol. She said:

This is a strange picture… I thought they started building the walls from the bottom…

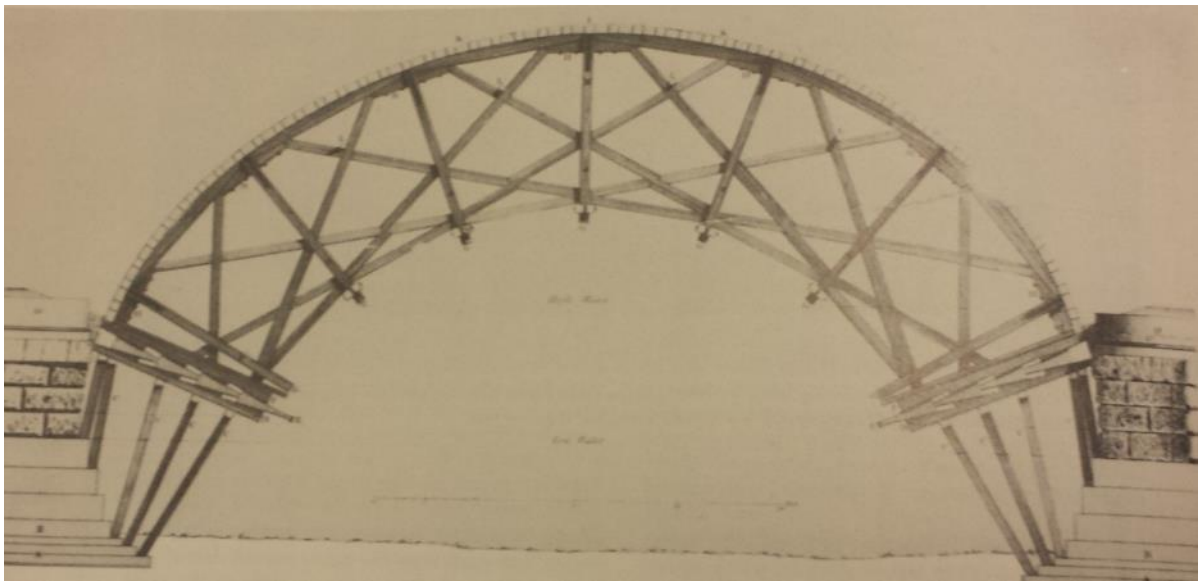


Perhaps we will come to that another month, but let's look at the centring here.

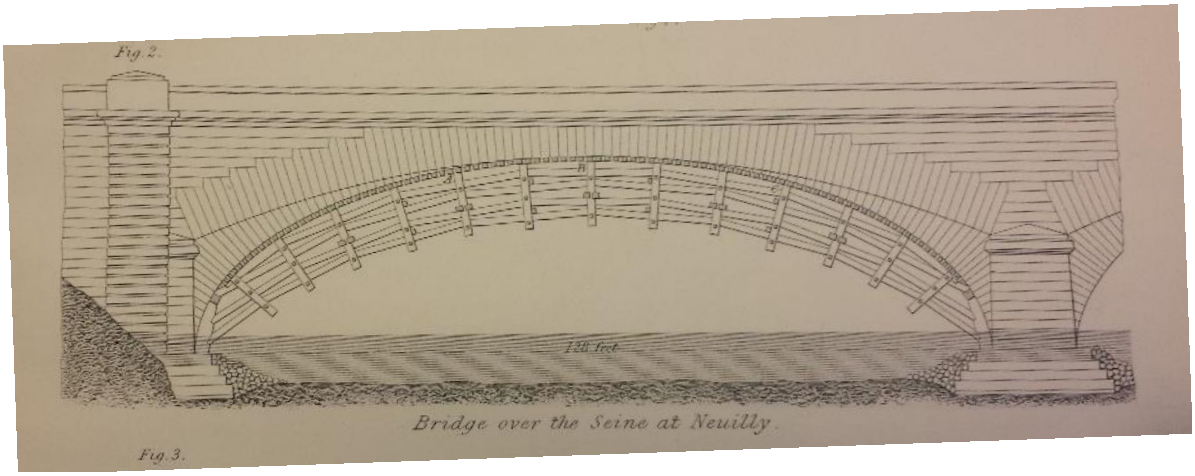
I have seen illustrations of this form of construction before but mostly more recent. Here, we see the date as August MDCCLXIIII, 1764? Robert Mylne, like Robert Adam, his contemporary, was son of a Scottish mason. He was working at the same time as Perronet in France and one wonders how closely they followed each other's work. More on Perronet shortly but first let's look closely at this frame. The drawing shows slight lack of alignment of the members but they run in essentially a straight line from the load point to the support. At each point, it is possible to see which member passes through and which is jointed. Timbers

of such a size, long enough to reach the full length were surely rare even in those days. One would expect the pieces to be cut to produce maximum stability for minimum length, but also to create as many repeats as possible. The outer radius changes (this is a three centred arch) but much less than in some arches.

A proper elevation gives a much clearer picture.

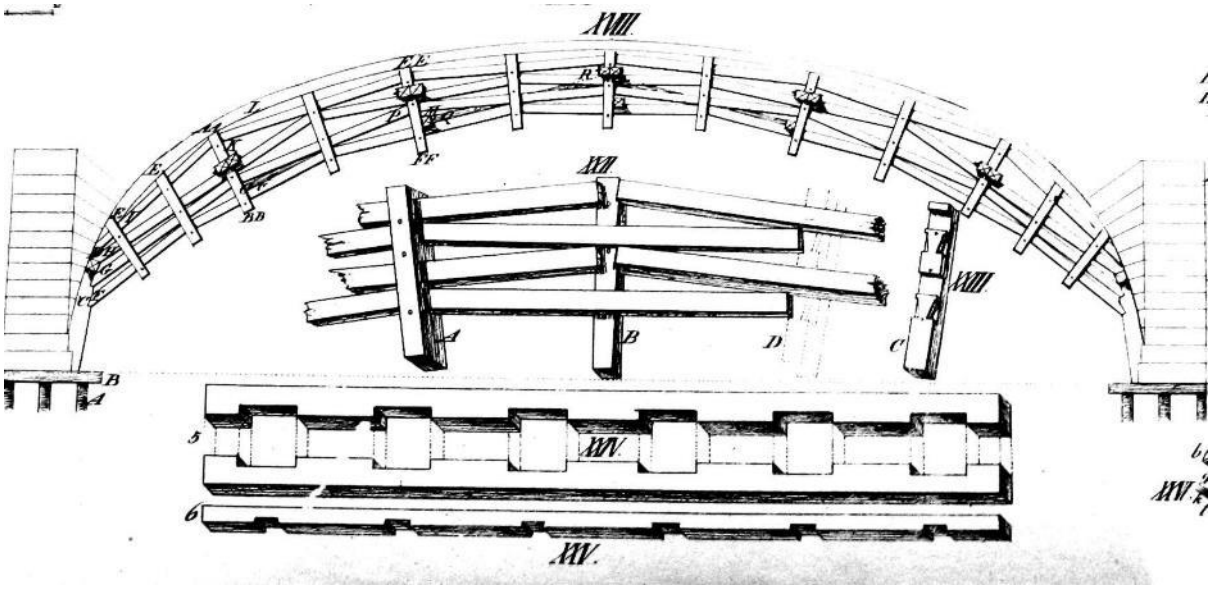


Before I say more, let's look at Perronet's centre for his bridge at Neuilli.



At first sight, they may look closely related but in fact Mylne's is a thoroughly triangulated structure while Perronet's is a very flexible arch.

Both, though, make use of a trick of timber design. They use pairs of timbers to create open joints that can be assembled easily in the air. They then use another pair of timbers at right angles notched to hold the first pair together.



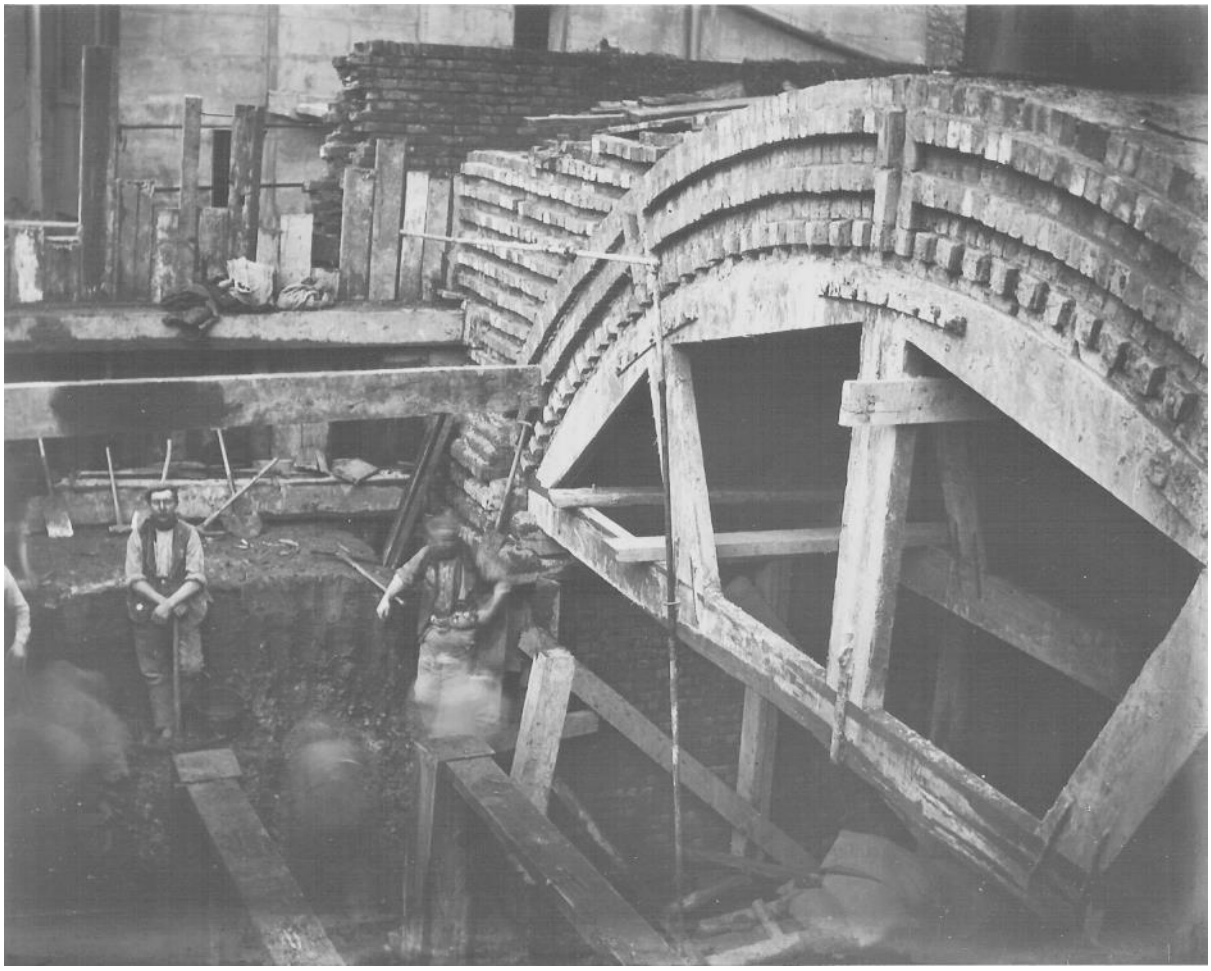
In fact, with Perronet's flatter arch, little would be gained by carrying timbers through and intersecting them. The structure would become vastly more complex without marked gain in stiffness. Perronet had to ballast his centre at the crown to stop it bursting upwards as the arch was built out from each end. Mylne's frame, though proved capable of sustaining the added weight of spandrel and parapet on the crown with just the bare arch on the centre (See figure 1 above).

Big bridge centres are vastly expensive but what of the smaller bridges built in hundreds over the centuries. The evidence is often gone, but sometimes one comes across lingering evidence of something unusual. Cadamstown deserves a BoM of its own but the centring is fascinating.

The lower part of what looks like an arch here is actually built in corbel and there was a deck at that level of logs and (presumably) planks for some time. When the bridge was raised and became an arch, it looks as though the “centre” was made by the simple expedient of piling brashings on the old bridge.

This picture clearly shows evidence of the twigs captured in the mortar on the intrados. I suspect that the brashings were not even removed but left to rot and fall into the river.

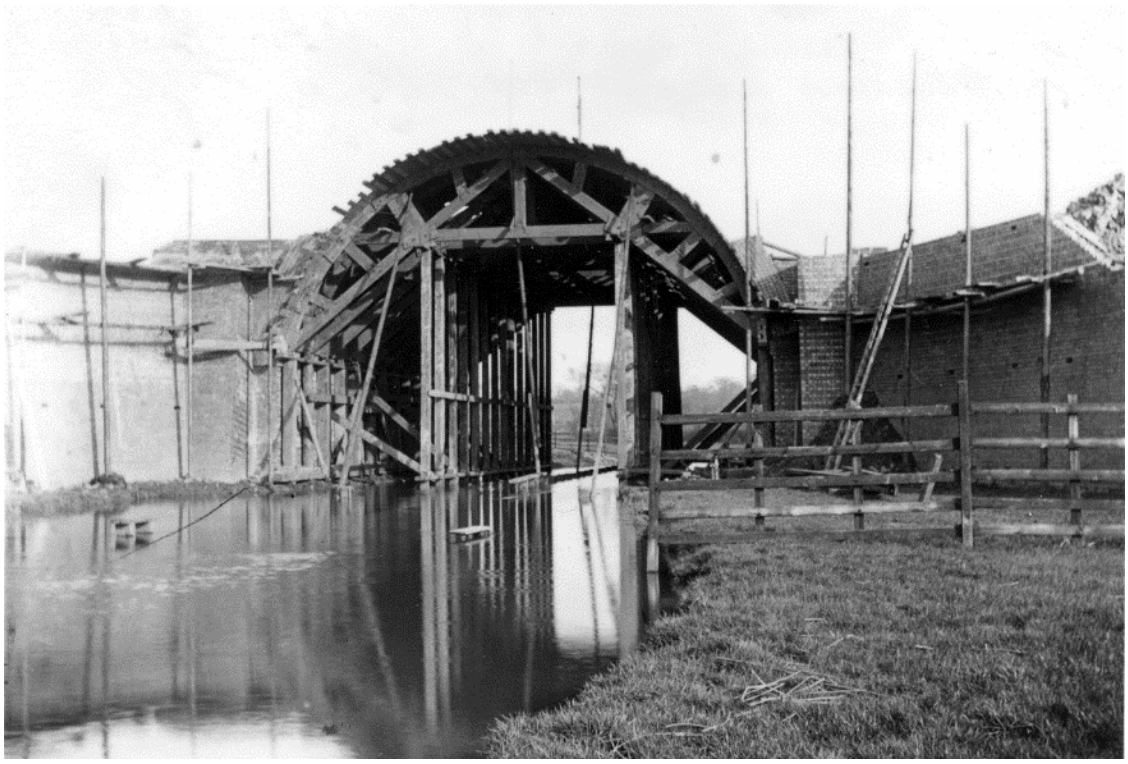
On an intermediate scale are the railway and canal bridges, built in large numbers by a single contractor who naturally wanted to re-use his expensive timber. Modern timber construction leads to the assumption that centres were trussed as a matter of course but that means lots of cutting and lots of short timbers that are very hard to re-use.



This arch on the Great Central line has a centre of heavy, robust timbers. They are joined with iron straps to avoid complex cutting and minimise damage. The “tie” is held to the bottom chord by a strap round, indicating that the engineer expected tension, while the side struts are cut to fit and simply stapled to the tie. The centre is intended to be held together by the main beam but to work as a stiffened arch once erected. Note also, the scale of the lagging timbers below the toothed inner ring of bricks. They are 12x3inches or 305/75mm. Solid enough to withstand many reuses, even when they had to be removed from the frames and replaced for each bridge.

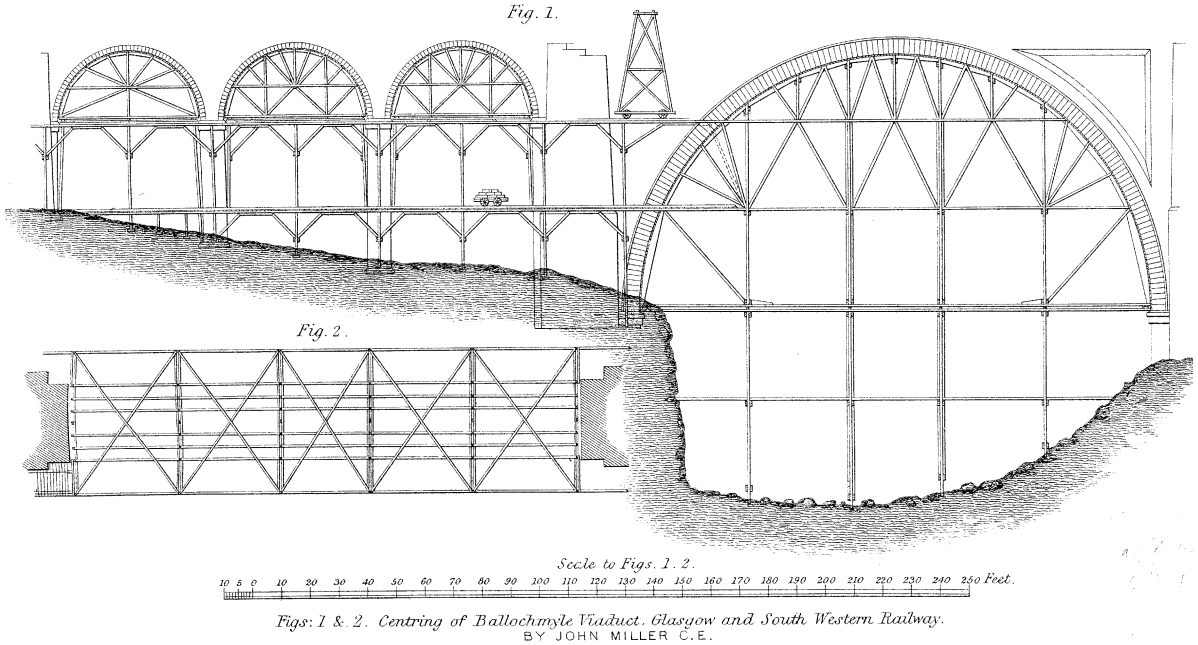
This style would even be used for rather bigger spans. Here (below) we see a skew bridge where the span is long enough that the engineer felt a need to provide a central prop.

Slightly bigger, and some measure of trussing was needed as seen below. Is this made from two shorter span centres pitched up together?



The span below is against a king pier but the centring still includes a main tie at springing level and diagonal struts to the crown to provide the main stiffness.

Finally, though I think I have included it before, perhaps the centre for Ballochmyle is worth another visit.



Figs: 1 & 2. Centring of Ballochmyle Viaduct. Glasgow and South Western Railway.
BY JOHN MILLER C.E.

Note the scale of feet that shows the frame to rise in lifts of nearly 50feet, at least 15m.

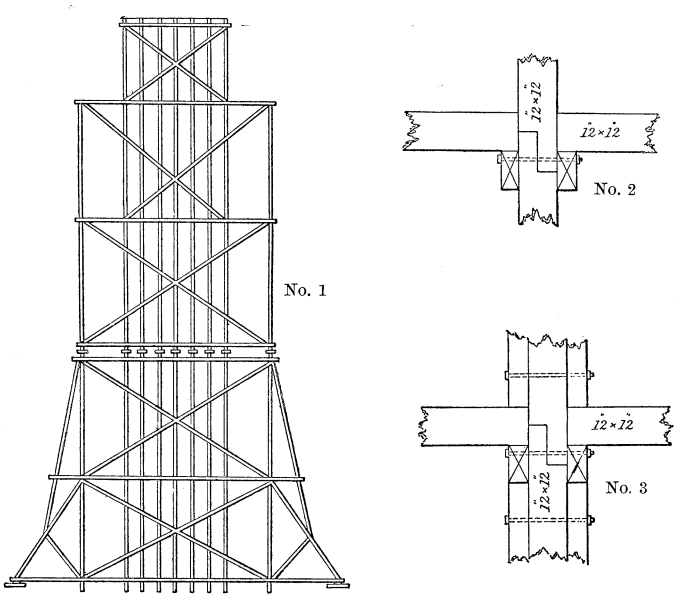


Fig. 882.—Section and Details of Centring of Ballochmyle Viaduct (see Plate LXIII)

A cross section of the tressle shows the wide platform on which a gantry crane runs. The details indicate the shear scale of the timbers.

It is worth a look at Lugar in this context. Same railway, same engineer. Modest spans and the centres supported from the ground many metres below. Why would he do that? Presumably because having a crane platform offset the cost of building the tressle.