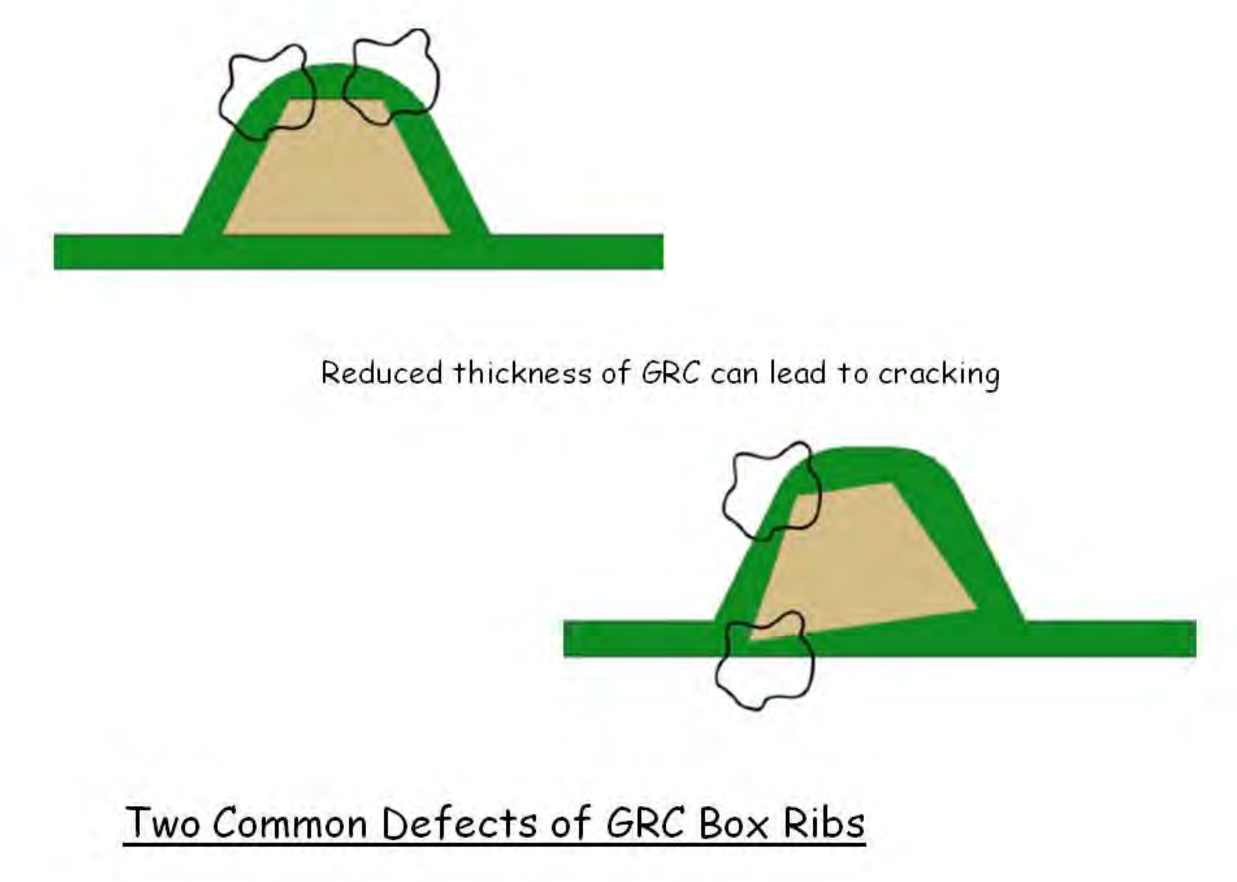
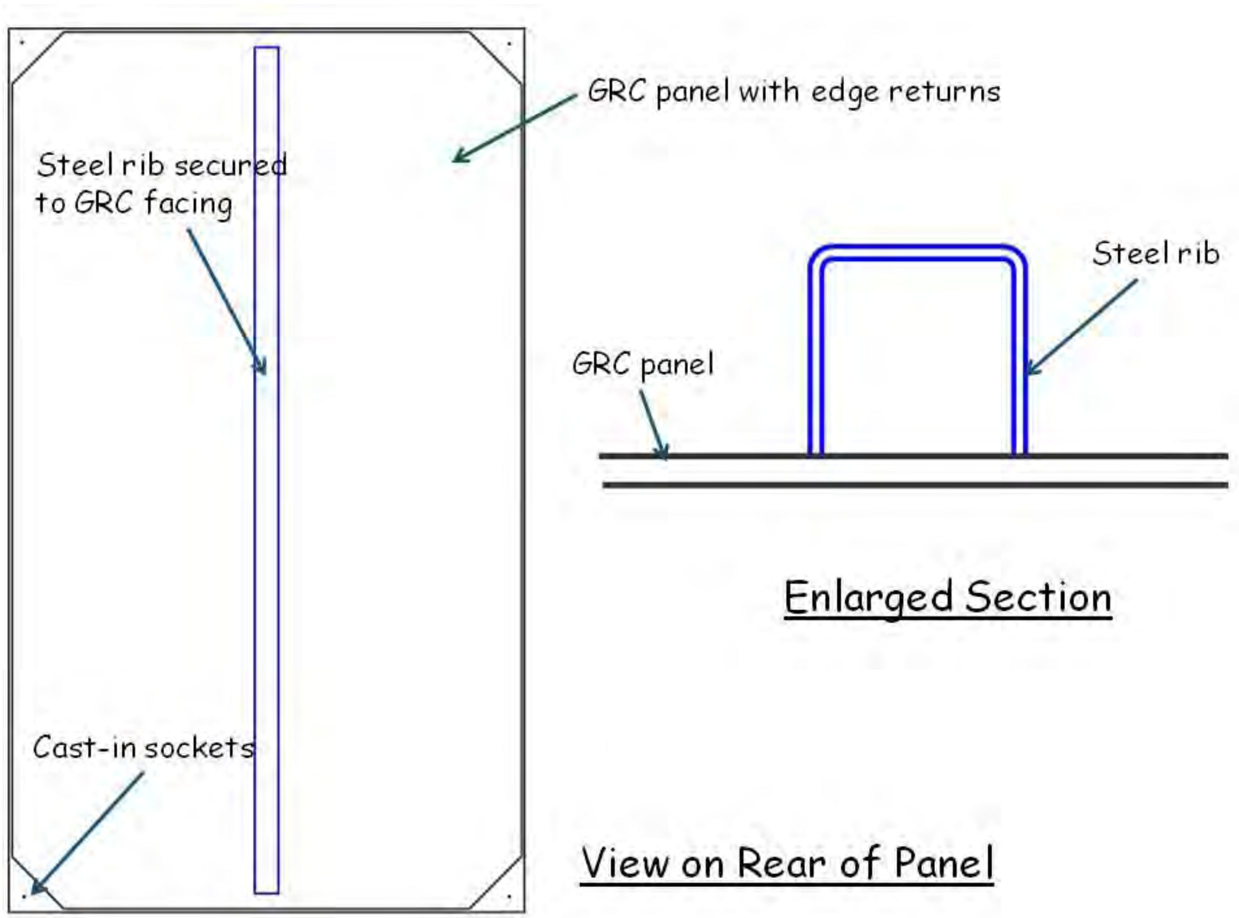
23 Composite Steel Rib Construction of GRC Box Rib Cladding Panels

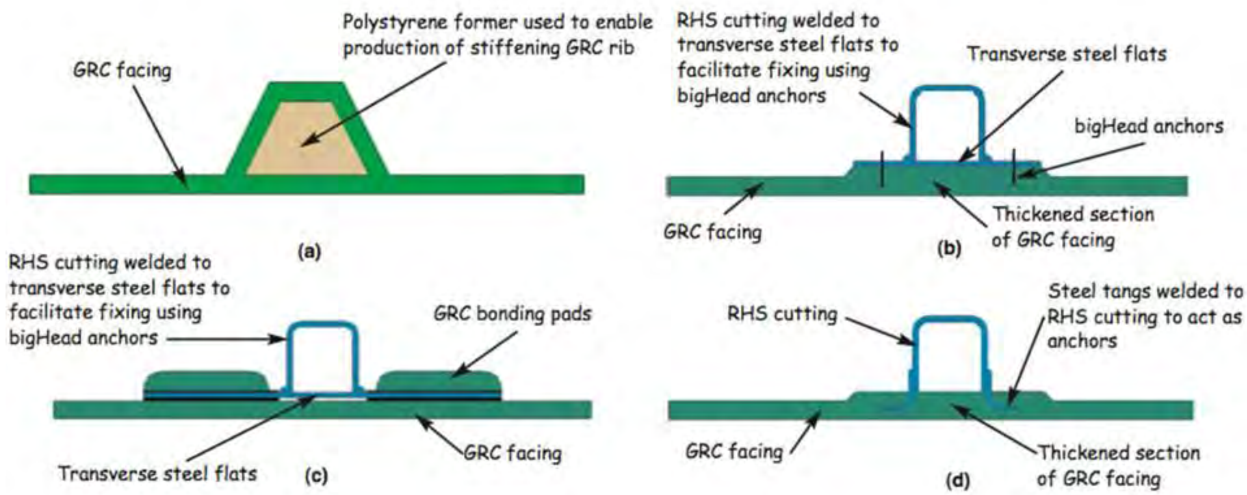
Glyn Jones
Consultant, UK



Conventional box rib construction using polystyrene formers is difficult and time consuming. In using this method for forming stiffening ribs, the defects shown here may occur. This is usually caused by over rolling and exerting too much pressure on the roller.

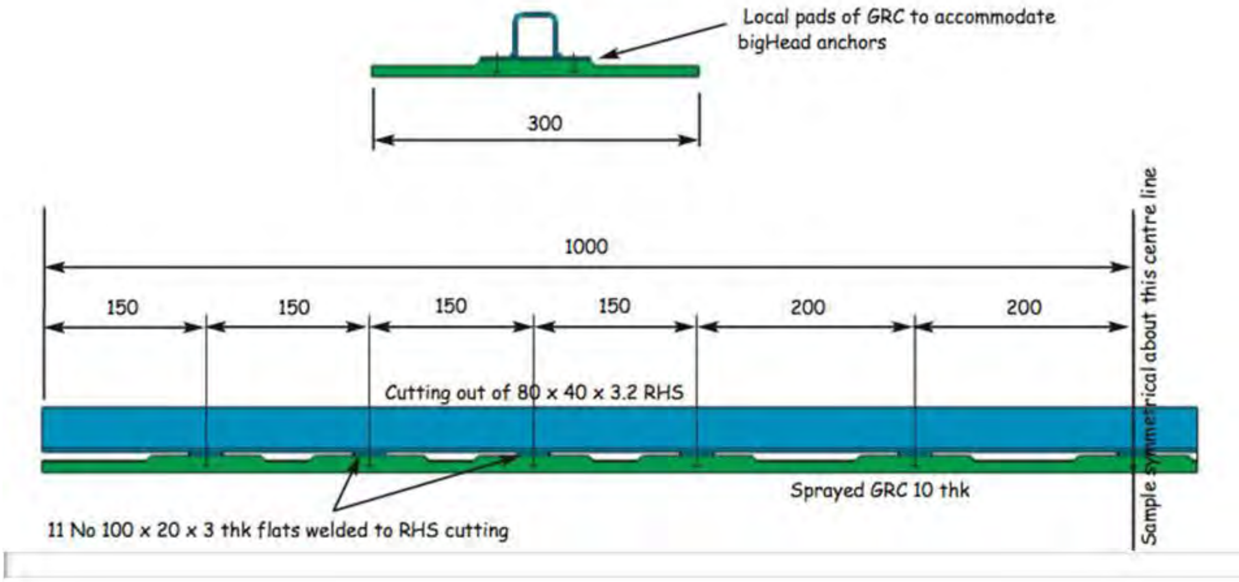


Composite steel ribs offer a much better alternative in terms of quality of the finished product, albeit at a higher cost of materials. However, the saving in the cost of labour and faster turnaround times may substantially offset this cost increase. The exploratory tests carried out by the GRCA considered three alternative methods of securing the steel rib to the GRC facing. Only sprayed samples have been tested up to now, but premix samples will also be tested at a later date.

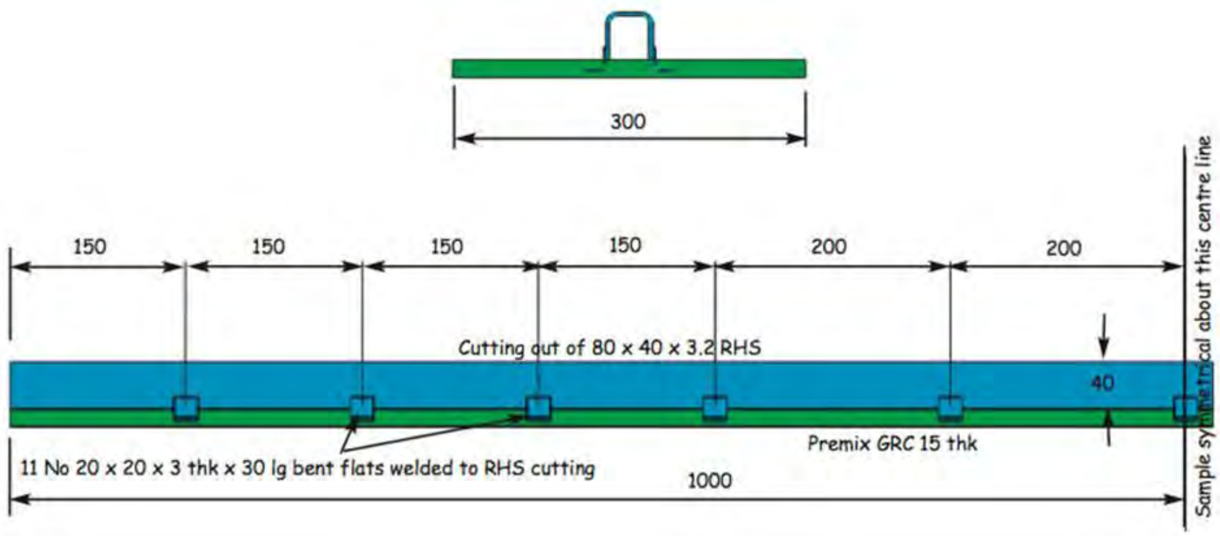


Three alternative forms of composite, steel rib construction were considered for comparative load testing to destruction. Fig (a) shows conventional rib construction.

Fig (b) indicates how bigHead fasteners can be used. The construction shown in Fig (c) uses steel flats welded to the steel rib and bonded to the GRC facing by conventional bonding pads. Finally, Fig (d) illustrates how bent steel tangs welded to the steel rib can be used to effect the connection. Both the methods shown in Figs (b) and (d) require a local thickening of the GRC. Clearly, the method using welded flats cannot be used in premix construction.

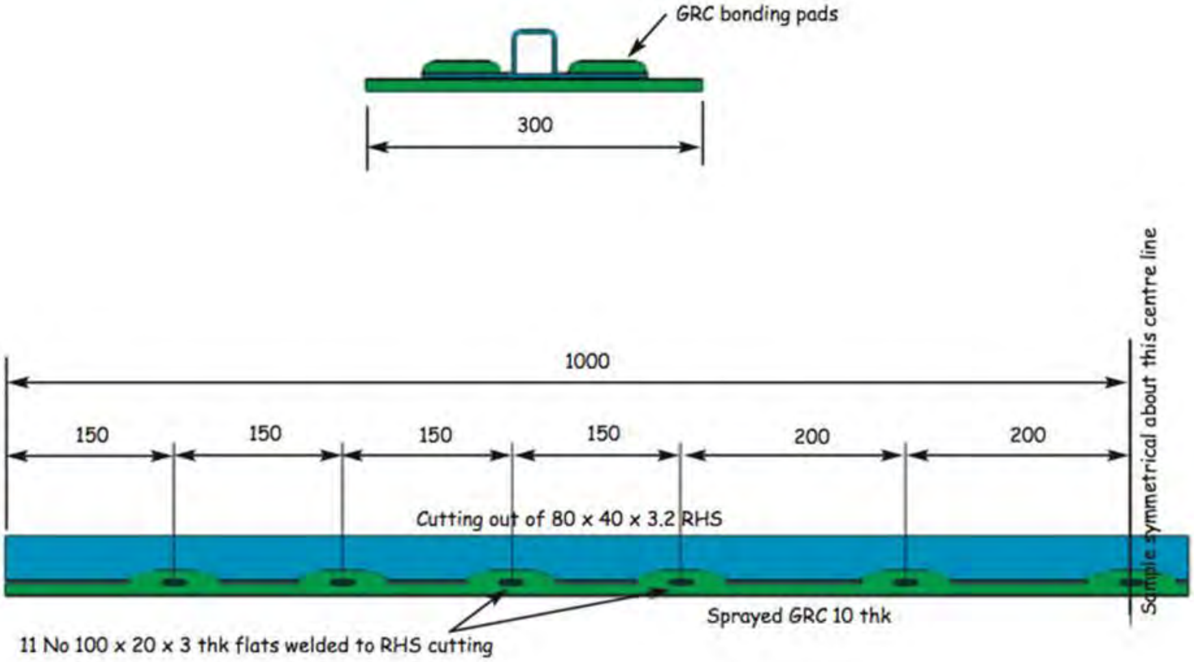


This slide shows details of the test specimens using bigHead fasteners in sprayed GRC construction

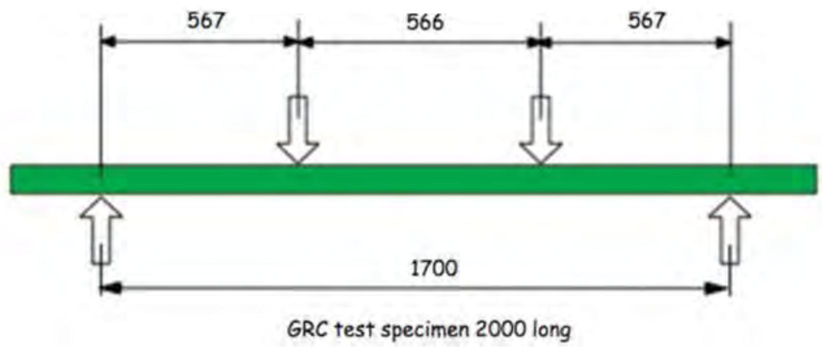


Likewise, this slide shows details of bent flats (tangs) method of construction.

v



Lastly, this slide shows details of the steel flats method of fixing. All of the test carried out to date have loaded the GRC face to simulate positive wind loading. When samples are tested for the effect of negative wind pressure, some form of loading bridge will be required as shown in this slide. This ensures that the loading acts directly on the GRC.



All of the test carried out to date have loaded the GRC face to simulate positive wind loading. When samples are tested for the effect of negative wind pressure, some form of loading bridge will be required as shown in this slide. This ensures that the loading acts directly on the GRC.

This photo shows part of the loading rig used to carry out the tests.


All the test samples had GRC facings 300mm in width. This slide shows a test specimen using bigHead fasteners to secure the steel rib.

This photo shows a test sample using bent tangs to anchor the steel rib into the GRC facing.

This photo shows the steel flat construction after failure. The supports were applied directly to the GRC facing to simulate the cladding panel construction shown earlier.

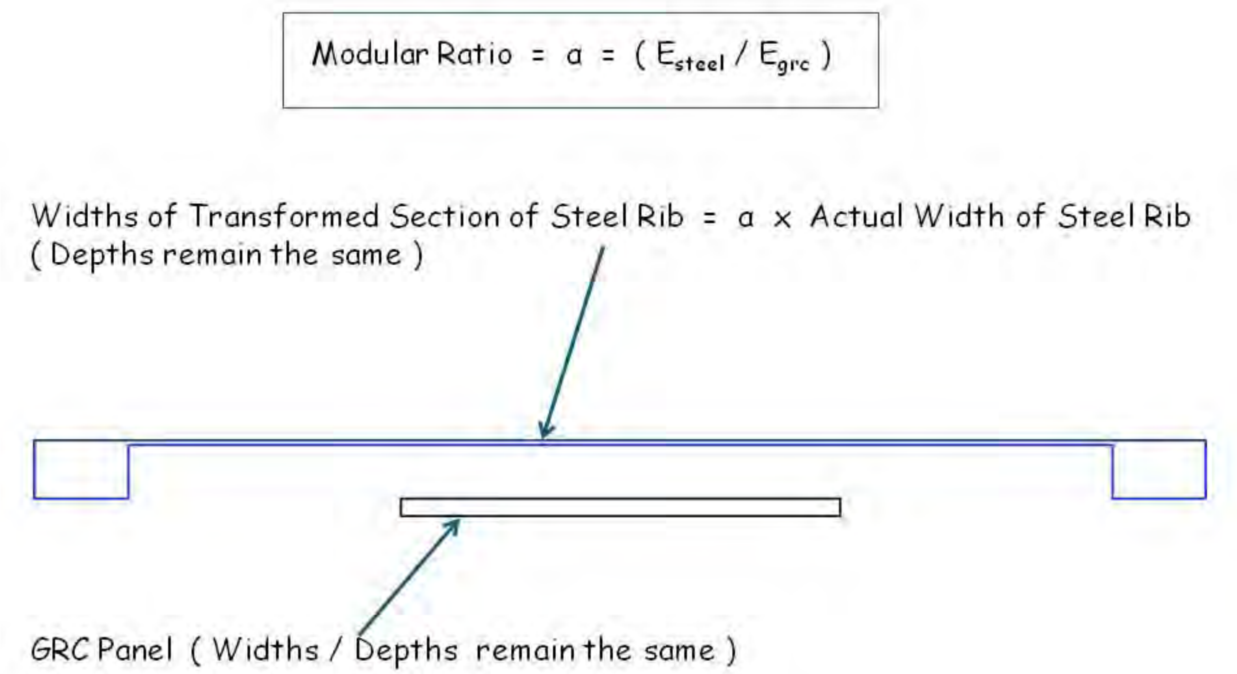
However, all of the composite constructions failed locally close to the supports. All test samples, except the one using bent tangs, failed at a load exceeding the estimated failure load, as will be illustrated later.

This slide shows the local thickening of the GRC necessary for the bigHead method of construction.

All of the test samples to date suffered a local bending/shear failure close to the supports as shown here for the bigHead fastenings.

This slide shows the failure a little clearer. Remember, it was the GRC facing that was loaded directly. Hence, the sample shown here has been turned upside down to examine the failure.

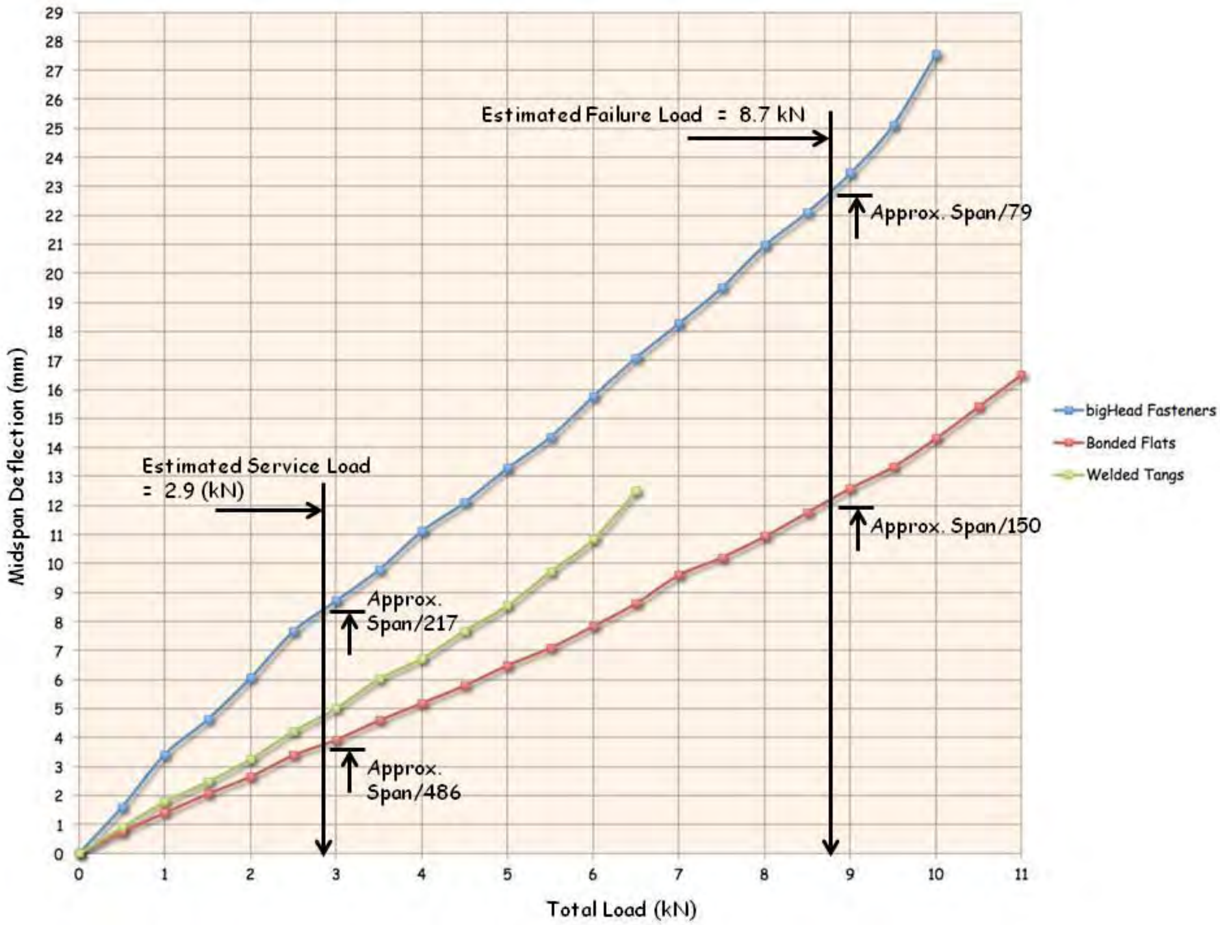
The same comments apply to both the bent tang and welded flat metods of construction. This slide shows a sample using welded flat connectors. The failure of the bent tang samples were similar, albeit at a smaller failure load.



Transformed Composite Section

The method used to estimate the failure load was the conservative ‘Transformed Section’ method. This converts the steel rib to an equivalent section of GRC so that the calculations all relate to the same material, namely, GRC. Here, the modular ratio of steel to GRC is used to increase the widths of the steel rib whilst not changing the depths.

This method yielded an estimated failure load of 8.70 kN for the samples under test.



These plots of Load against Deflection reflect the best data collected during these initial tests. The welded flats produced the best results, ie lowest deflection for a given load, followed by the welded tangs and the bigHead fixing system. The welded tangs did not reach the ultimate loads reached by the other two nor did it attain the estimated failure load of 8.70 kN.

Whilst all three failed local to the supports, the different geometries must account for the differences in failure loads,

Both the welded flats and the bigHead fasteners systems exceeded the estimated failure load by about 15 – 20%.

Click mouse to reveal estimated values at failure and at the ultimate limit.

It is important to know that the welded flats construction was also the easiest to manufacture.

The serviceability deflections of Span/217 for the bigHead system and Span/436 for the welded flats compare favourably with the basic value of Span/250 specified in BS 8110.

Further Exploratory Tests on Composite Ribs

Further testing is to be undertaken for both sprayed and premix materials. As well as steel ribs, it is intended to investigate the performance of GRP pultruded sections.