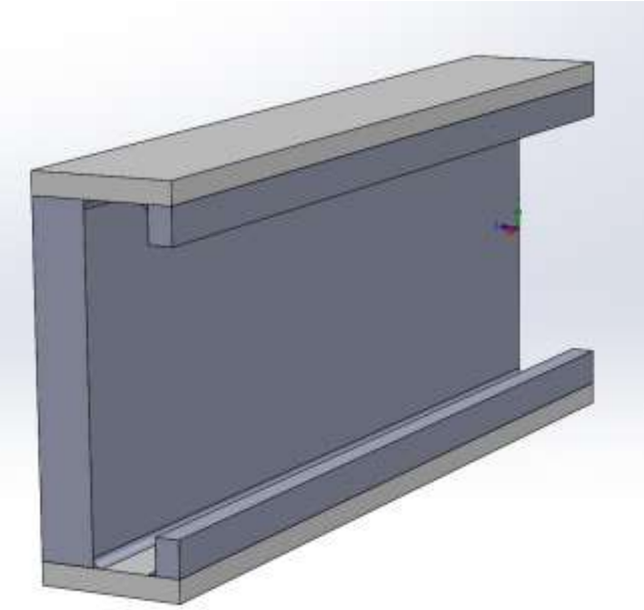
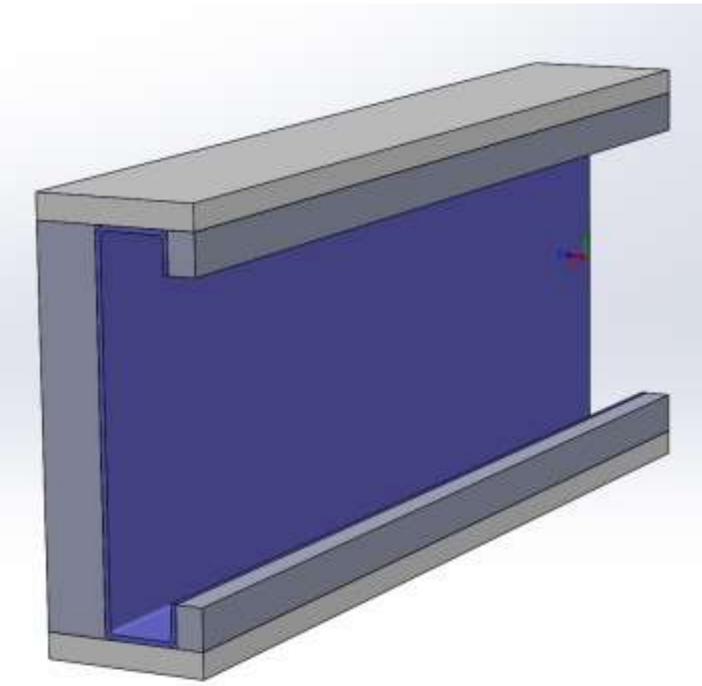
Use timber to make a single mould screwed together so that it can be dismantled to release parts, cross section something like this (details to suit material available):

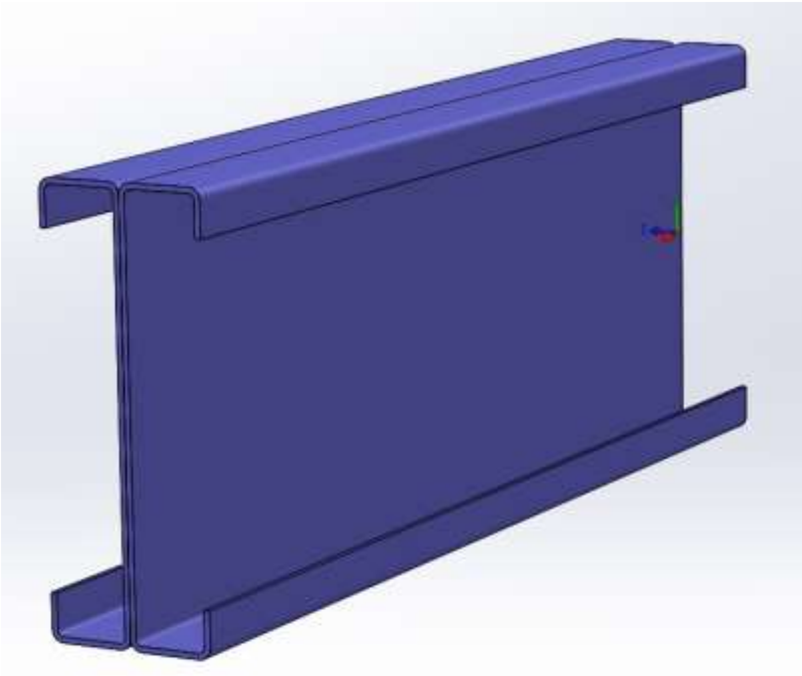


All these drawings show a 1metre length of beam, the overall height and width being 392mm x 146mm – the dimensions of the largest cross section of Beam C-C in the James Wharram drawing provided. The actual mould and mouldings will vary in height along the beam length to match the existing beams

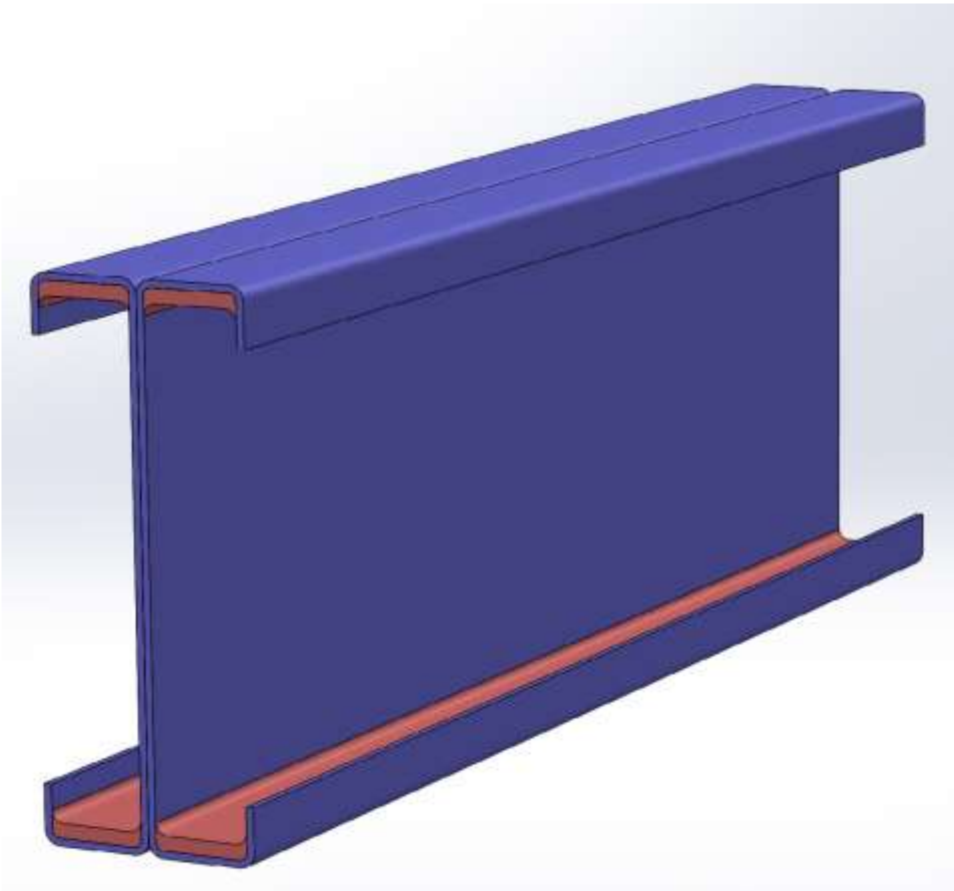
Layup mould like this with biaxial E glass to about 4mm thickness e.g. 8 layers of 600gsm – (in these drawings red is uniaxial and blue is biax):



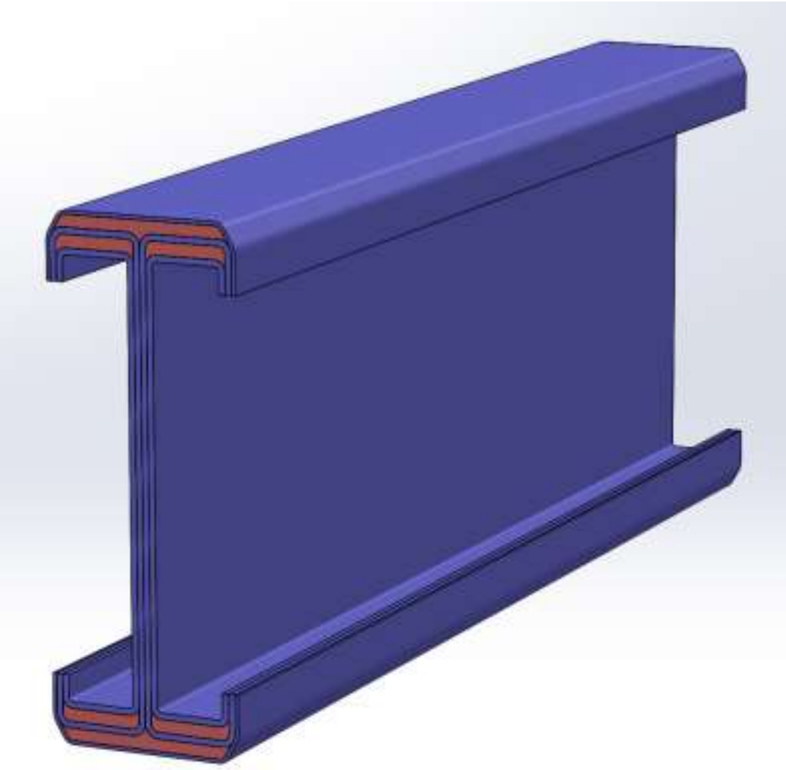
Do this twice for each beam to make two side pieces for each beam. Turn one side piece end for end and bond the two side pieces together like this:



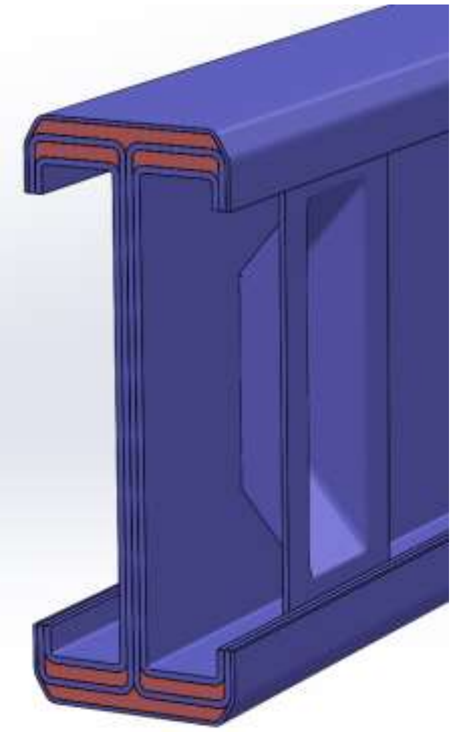
Add unidirectional layups, about 10mm thickness e.g , 13 layers 900gsm like this:



Then add further unidirectional and further biax, same thickness layers as before, like this:



Then make a separate small mould and layup some 'pockets' that can be bonded and tabbed into the sides of the beams as necessary to support the ends of the existing timber members that support your decking. Also add such members to strengthen the flanges where there are crushing loads from above, eg at the lashing points. Like this:



Then laminate end caps with flanges to retain lashings like this:

It would be necessary to include small drainage holes to avoid water collecting in the turned up lower flange.

If you wanted to exactly match the appearance of the original wood beams and avoid drainage holes it would be possible to mould light profiled skins to bond onto the sides of the beam but I think this might be quite a lot of work for little benefit.

This composite beam is designed to match the bending stiffness of the original wood beam since it is (arguably) the bending stiffness that is the most important property to match to make the alternative constructions equivalent. I then did an approximate calculation which showed that the composite beam of similar stiffness would be about 70% of the weight and would be 1.8 times stronger in bending than the wood/epoxy beam, as well as being free from wood rot. For this calculation I determined the weights, bending strength and stiffness of the beams assuming:

- 0.45 glass content by volume giving a density for the composite of about 1900kg/m3
- Wood density 600 kg/m3
- Wood elastic modulus 12GPa
- Wood flexural strength 103 MPa
- Unidirectional comp elastic modulus 40GPa (combined resin and E glass)
- Unidirectional comp flexural strength 600MPa (combined resin and E glass)
- for the wood/epoxy beam assumed all the bending load is carried only by the 6 in number 1" thick layers of timber at top and bottom of the beam i.e. assumed that the ply webs and the fillets serve only to carry torsional load and hold the top and bottom timber apart and also neglected any structural contribution from the epoxy/glass sheathing.
- For the composite beam assumed all the bending load is carried only by the unidirectional composite built into the top and bottom of the beams, i.e. assumed that the biaxial composite serves only to carry torsional load and hold the unidirectional laminate in position.

The last two assumptions probably balance out for the two alternatives.