Item	G.H.C Query	Madewell Response
1.	Regarding procurement of the material, do you require full schedules for production (i.e, similar to a traditional reinforcement schedule) or do you produce this in-house from our engineering drawings?	Require the schedule
2.	What is the lead time for production including shipping to WA?	Manufacturing lead time will depend on the quantity required. Let's just say that we have a production capacity of about 170 tons of V-ROD rebar per week, meaning about a full container load (25,000 kilos) every day or so. Allow 2 months for shipping and a week into WA from Melbourne.
3.	Are you able to provide an indicative cost for comparison of the product against traditional steel reinforcing bar? We are currently paying circa $2,400/t for processed bar here in Perth.	Depending on the dia as GFRP is 75% lighter LM rate is a better way to look at costs. 12mm & 16mm is currently the equivalent of steel LM pricing.
4.	How is the reinforcement tied on site? Do we use traditional steel ties? In one of the product presentation clips we noticed that the bars were ties with cable ties. Is this acceptable?	Yes, cable ties are acceptable, but we offer quicker solutions with automatic rebar tiers with a range of conventional or non-corrosive wire.
5.	What is the maximum length bar that you can produce?	11.8m fit s into a 40" container whereas a 5.8m fits into a 20" container.
6.	GFRP is not covered by AS3600 – concrete code. Is there an Australian equivalent code for the design of GFRP?	Not now. Refer to the codes below.
7.	GFRP is normally used in applications where ductility is not required – i.e. bridge elements, tunnel walls, wharfs and the like. AS3600 puts limits on re-distribution of bending moments in the structure if low ductility reinforcement is used – is there a way to avoid these limits when using GFRP?	Many studies have been conducted to investigate the re-distribution of the bending moment for GFRP-RC beams and slabs. The main findings were that the level of re-distribution is like steel-RC counterparts. The observed moment re-distribution was attributed to the relatively low modulus of elasticity of the GFRP bars making it possible to achieve the required section deformability for moment

		re-distribution to occur, although not to the same extent as in continuous steel-RC members. However, the current codes and standards do not permit re-distribution of the bending moment for GFRP-RC flexural members. As I am not aware of the AS3600 requirements, it is important to make a distinction between re-distributing the bending moments between the critical sections (negative and positive bending moments) and using the simplified procedure in calculating the bending moments. The codes allow procedures for estimating the bending moments by the simplified process, FEM, first-order analysis, etc., similar to steel-RCs.
8.	Do the formula's for calculating development lengths in AS3600 apply for GFRP?	Most available codes and standards use the same development length equations for GFRP as steel by replacing the yielding strength with the GFRP stress. However, it is judicious not to jump to the same conclusion with the AS3600. Therefore, it is suggested to use the development length equations dedicated to the GFRP bars presented by one of the GFRP codes (ACI 440.11, AASHTO LRFD GFRP BDS, CSA S806, CSA S6, etc.).
9.	What are the lap lengths for GFRP?	I am sharing the development length calculations based on the CSA S806 building code and the CSA S6 bridge code for GFRP bars. Note that these calculations are based on some assumptions, including developing the full

		strength of the bars, which is not the case for most of the design. The development length requirements are based on the actual bar stress, not the ultimate/guaranteed strength. This is because the GFRP design is mostly controlled by serviceability, and the bars do not attain their ultimate/guaranteed strength. Nevertheless, the development length calculations in the attached file are based on the ultimate/guaranteed strength.
10.	We understand that the compressive strength of the GFRP is ignored by standards. That means the structural elements working mainly in compression (columns, walls) should be design as plain concrete elements? Do the GFRP bars provide a similar confinement affect as the steel bars?	GFRP stirrups/ties provide similar, or higher, confinements as steel bars. This has been addressed by many studies. The higher strength of GFRP bars allows the concrete core to achieve higher strains compared to steel ties. Once steel bars are yielded, the concrete loses its confinement, while GFRP bars can achieve much higher stress before the concrete crushing.
11.	Is there a maximum recommended characteristic yield strength value for the GFRP rebars?	GFRP bars are linear elastic material and do not yield, therefore, they do not have a yielding strength.
12.	Are the GFRP rebars brittle? Are there any special measures to be taken during the pouring of the concrete for a suspended slab? In all the cases the concreters and other labourers will step on the rebars during the construction process.	GFRP bars are brittle, however, the tensile strength of the bars is three times higher than the yielding strength of the steel rebars. Additionally, GFRP bars are flexible and attain higher deformation compared to steel rebars due to the lower modulus of elasticity. Therefore, stepping over the rebar mesh during concrete pouring should not pose any issue, and there is not special measurement during

		the construction process in this regard.
13.	I read that the GFRP bars tend to "float" and might end up being displaced during the pouring of the concrete. Is there any methodology to keep them in place or just tie them to the formwork?	This has only been an issue during a precast scenario for concrete sleepers as an example. Where the vibration process is continuous and powerful.
14.	Can you please provide us the technical specifications of the GFRP bars than can be supplied in Australia? We are mainly interested in the Modulus of elasticity and the Characteristic uniform strain of the bars.	Spec sheet found on my original email for both straight and bend portions. 60GPa. I will resend this on the email reply.
15.	Is it safe to use a 0.65 value for the Stress reduction factor? (as pe the other low ductility reinforcement)	Coming back to you ont his one.
16.	Based on you knowledge, how far away from releasing an Australian code for these type of materials are the people working on that?	2-3 months away for the material specification. BD 108 committee have concluded the building and design code which might be a couple of years off going off the material code timing.