RESPONSE TO REVIEWERS

DESIGN OF A CARBON FIBRE PASSENGER CAR RIM

L.F MASERUMULE 0505585E

The author would like to thank all the examiners for their comments, which assisted in the improvement of the report. Their efforts are appreciated and their suggested improvements have been incorporated in the report. The details are outlined below.

1. Response to Examiner One

1.1 "Page 6, last sentence of paragraph 3. "The correlation between…. Will validate the finite element technique." This is only true if there is good correlation. In the case of poor correlation, the FE technique."

- ❖ To ensure that the is clarity the statement was changed to "A good correlation between the Ducati rim`s dynamic cornering fatigue experimental and FEA strain results will validate the finite element technique." Refer to page 6 paragraph 3.

1.2 "The material properties in Table 3 are still not correct. Although the in-plane moduli now seem appropriate, the Poisson`s XZ for the fabric materials are not correct. Likewise the shear modulus XZ for the fabrics should be the same as in the YZ direction rather than the in-plane direction. Since a balanced weave is used, it is not clear why the tensile and compressive strengths in the X and Y directions should be different. (The question must be asked: if the values are in fact different does the manufacturing process take account of the direction X vs direction Y. If not the lower values should be used. If not the lower value should be used.) Although I do not believe that the incorrect values of the Poisson`s ratios and out-of-plane shear moduli will make much difference to the final results, it is concerning that this issue persists even at the second attempt. What is the meaning of "Shear strain X direction" and equivalents in the other directions? The shear strains take place in a plane and not in a direction."

- ❖ The material properties were corrected and can be located table 3. This was corrected with reference to the material data sheet. The reference to temperature related material properties were also removed from table 3. Please note that the table was shortened to allow it to fit on to one page as per 1.4 requests.

1.3 “Is the transverse strain in the outer spoke -528 με or -582 με? Table 5 and page 45 give different answers. Likewise for the in plane shear strains in the inner spoke, -652 με or -662 με?”

- ❖ The typos were noted as discussed and rectified (refer to page 45). The values in table 5 are the correct values.

1.4 “Don`t split tables- Applies to Table 3 and Table 5 and possibly others”

- ❖ Table 1, 2,3,4,5,6,7,8,9,10,11 has been rectified and they not been split between 2 pages.

1.5 “Page 48, first paragraph. Is correlation within 25 % the magic number? Justify your sections.”

- ❖ No reference paper could be found which explicitly indicates the reasonable correlation range for composite structure FEA with experimental testing results. The reference paper to explain the 25 % is Smith, B., Kienhöfer, F., (2015) “A Carbon Fibre Swingarm Design.” R&D Journal of South African Institution of Mechanical Engineering, pp. 1-11. The paper highlights the experimental testing and FE modelling of the swingarm. The experimental and FE strains and deflections were compared; “The differences between the FE and experimental deflections were 5% (vertical) and 28% (torsional). The reason for the large difference in the torsional deflections is explained by the FE model not including ply overlap. In the FE results that follow, the longitudinal results are relatively accurate but the results depending on the transverse properties of the laminate are less accurate; which is consistent with the explanation of the less accurate torsional deflection results.”

1.6 “Page 48, last paragraph. The term is inverse reserve factor- not reverse factor! (Minor typo).”

- ❖ The terms RF (reserve factor) and IRF (Inverse reserve factor) have been corrected .

1.7 “Equation 6.3. How are the maximum allowable strains in each direction calculate? Please explain. Currently, I am assuming that you have determined these from table 3, in which case they are the strains that correspond to static failure- not fatigue failure. The fatigue life under the conditions where f_{max} is close to I will be very short.”

- ❖ The maximum allowable strains are dependent of the material properties presented in table 3 and the layup of the composite. The strains in each direction are calculated based on the upper limits of the material properties and layup. Figure 85 shows that the fatigue strength of carbon fibre RF is 90% of its static strength and the IRF values are well below 0.9 .

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1.8 “Section 7.1.2 and 7.3.2 and elsewhere such as discussion, conclusion etc.- Results and discussion are presented for the value of f_{max} which is an indication of how close the failure one is in terms of the maximum strain failure criterion. The value is not the actual strain as indicated in all the figures and discussion. This shows lack of understanding! ”

- ❖ This error was corrected. f_{max} is now presented as a dimensionless factor which represents the inverse reserve factor and not a maximum strain. This is a ratio between actual strain and maximum strain to failure, which indicates the probability of static failure.

1.9 “Page 86- I have serious reservations about the thicknesses that are calculated and presented in table 12. To obtain a satisfactory fatigue life from the car rim, it is necessary to thicken up the structure of the Ducati rim so that it can withstand 2000 Nm of load instead of the 700 Nm that the motorcycle rim was designed for. This means that the structure should be about 2000/700 times thicker than the motorcycle rim – assuming similar layups etc. this is a factor of 2.857 or about 185 % thicker than the motorcycle rim. In fact since the thickness can only increase inwards, additional material becomes increasingly ineffective. This means that that my value is actually too low. To present thickness changes of only 61 %, indicates to me that the strains in the new rim are much higher than those in the motorcycle rim when subjected to motorcycle loads. I do not believe that the fatigue life will be acceptable. This is a major issue that cuts to the heart of the entire project."

- ❖ The Ducati rim tested at 700 N.m loading did not fail at this loading. The test at 700N.m was done to validate the FEA model. The point that the thickness on the real rim can only be increased inwards and the FEA model is thus not 100 % and in fact the model underestimates the strains is noted.

1.10 "Page 86, second bullet from bottom. Again, here it is indicated that the f_{max} is less than 1 and so the no failure from fatigue will occur. I think that again, the candidate has a lack of understanding – this just means that the wheel will not fail in static loading"

- ❖ This error was corrected. f_{max} is now presented as a dimensionless factor which represents the inverse reserve factor and not a maximum strain. This is a ratio between actual strain and maximum strain to failure, which indicates the probability of static failure.

1.11 "Page 88- See previous point."

- ❖ Refer to comment of 1.10.

1.12 "The presentation of the work in the report has been significantly improved, since the last attempt; however omission of the apostrophe to signify possession is still a problem.

- Substantial editing has been done and many grammatical and typographical errors corrected.