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Development of a carbon fibre swingarm

Smith, Bevan Ian

2014-09-03
http://hdl.handle.net/10539/15370

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ABSTRACT

Carbon fibre has not been extensively used in the development of motorcycle swingarms. This study investigates the development of a carbon fibre swingarm with an emphasis on the structural integrity and on developing a finite element model (FEM).

The motorcycle swingarm is a critical component in the rear part of the motorcycle. The literature shows that swingarms need to be strong enough to handle various loads experienced in the field, stiff enough to increase motorcycle response and stability, and light enough to improve motorcycle performance and reduce the rear unsprung mass. To this end carbon fibre was used in the design of a swingarm for a Ducati 1098 motorcycle due to its high stiffness and strength to weight ratios. The current research presents the first step in the design process of a single-sided carbon fibre swingarm.

A test rig was developed for testing the stiffness and strength of swingarms. Vertical, lateral and torsional stiffness values of 500 kN/m, 445 kN/m and 550 Nm/deg respectively, were determined from deflection measurements. The lateral and torsional stiffness values are on the lower spectrum of stiffness values when compared with swingarms measured in the literature which suggests the swingarm will exhibit a sluggish response and reduced weave mode stability at medium to high speeds. To determine the strength, strains were measured on the swingarm. Maximum strain values of 1100 με were measured which are considerably lower than the ultimate strain of 8000 με for the material which indicates the swingarm is strong enough.

Furthermore, a finite element (FE) model was developed so that later design iterations could be completed more quickly and cheaply. The FE model showed good correlation with the vertical displacement results (difference ≈ 4%); the torsional deflection difference was approximately 28% and the lateral deflection difference, 50%. The experimental lateral loading used was 133 N, resulting in a displacement of 0.3 mm as compared to the experimental vertical loading used which was 8000 N, resulting in a displacement of 16.5 mm. The error due to lash and bedding in which is plausibly in the region of 0.15 mm is likely the cause of the poor correlation between

the measured and FE lateral deflection results. The strains calculated by the FE model showed both good (less than 10% difference) and poor (larger than 100% difference) correlation. Plausible reasons for the poor correlation results were determined to be largely due to the influence of ply overlap and to a lesser extent, gauge misalignment and gauge placement accuracy. The first iteration of the prototype carbon fibre swingarm is 1.5 kg lighter than the original aluminium swingarm. Future work will look to improve the stiffness of future swingarm designs using the FE model.