World Academy of Science, Engineering and Technology
International Journal of Aerospace and Mechanical Engineering
Vol:13, No:04, 2019

Biaxial Fatigue Specimen Design and Testing Rig Development

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Abstract : An elastic analysis is developed to obtain the distribution of stresses, strains, bending moment and deformation for a thin hollow, variable thickness cylindrical specimen when subjected to different biaxial loadings. The specimen was subjected to a combination of internal pressure, axial tensile loading and external pressure. Several axial to circumferential stress ratios were investigated in detail. The analytical model was then validated using experimental results obtained from a test rig using several biaxial loadings. Based on the preliminary results obtained, the specimen was then modified geometrically to ensure uniform strain distribution through its wall thickness and along its gauge length. The new design of the specimen has a higher buckling strength and a maximum value of equivalent stress according to the maximum distortion energy theory. A cyclic function generator of the standard servo-controlled, electro-hydraulic testing machine is used to generate a specific signal shape (sine, square,...) at a certain frequency. The two independent controllers of the electronic circuit cause an independent movement to each servo-valve piston. The movement of each piston pressurizes the upper and lower sides of the actuators alternately. So, the specimen will be subjected to axial and diametral loads independent of each other. The hydraulic system has two different pressures: one pressure will be responsible for axial stress produced in the specimen and the other will be responsible for the tangential stress. Changing the two pressure ratios will change the stress ratios accordingly. The only restriction on the maximum stress obtained is the capacity of the testing system and specimen instability due to buckling.

Keywords : biaxial, fatigue, stress, testing
Conference Title : ICDAMA 2019 : International Conference on Developments in Aerospace Materials and Applications
Conference Location : New York, United States
Conference Dates : April 22-23, 2019