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Engine Thrust Estimation by Strain Gauging of Engine Mount Assembly

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Abstract : Accurate thrust measurement is required for aircraft during takeoff and after ski-jump. In a developmental aircraft, takeoff from ship is extremely critical and thrust produced by the engine should be known to the pilot before takeoff so that if thrust produced is not sufficient then take-off can be aborted and accident can be avoided. After ski-jump, thrust produced by engine is required because the horizontal speed of aircraft is less than the normal takeoff speed. Engine should be able to produce enough thrust to provide nominal horizontal takeoff speed to the airframe within prescribed time limit. The contemporary low bypass gas turbine engines generally have three mounts where the two side mounts transfer the engine thrust to the airframe. The third mount only takes the weight component. It does not take any thrust component. In the present method of thrust estimation, the strain gauging of the two side mounts is carried out. The strain produced at various power settings is used to estimate the thrust produced by the engine. The quarter Wheatstone bridge is used to acquire the strain data. The engine mount assembly is subjected to Universal Test Machine for determination of equivalent elasticity of assembly. This elasticity value is used in the analytical approach for estimation of engine thrust. The estimated thrust is compared with the test bed load cell thrust data. The experimental strain data is also compared with strain data obtained from FEM analysis. Experimental setup: The strain gauge is mounted on the tapered portion of the engine mount sleeve. Two strain gauges are mounted on diametrically opposite locations. Both of the strain gauges on the sleeve were in the horizontal plane. In this way, these strain gauges were not taking any strain due to the weight of the engine (except negligible strain due to material's poison's ratio) or the hoop's stress. Only the third mount strain gauge will show strain when engine is not running i.e. strain due to weight of engine. When engine starts running, all the load will be taken by the side mounts. The strain gauge on the forward side of the sleeve was showing a compressive strain and the strain gauge on the rear side of the sleeve shows a tensile strain. Results and conclusion: the analytical calculation shows that the hoop stresses dominate the bending stress. The estimated thrust by strain gauge shows good accuracy at higher power setting as compared to lower power setting. The accuracy of estimated thrust at max power setting is 99.7% whereas at lower power setting is 78%.

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