

Failure Analyte of Helicopter Wing: A Study

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Abstract

Summarised issued form is description of different failure cases of winged propulsions. Ethic is basic study from usual aircraft powered through rotary wing i.e., helicopters. Rotor wing composes lift capability by spins; otherwise, accessed score is obtained from aerodynamic lift. Rotor spins about an axis so that etiquette is aligned either vertical or side-to-side. Advent of rotary wing aircraft are that used to be practice is to take off and land vertical horizon. Aim is to hover for some kinds of rescue operation as well as fly slowly under same provision. Incidence of failure has studied, in lieu, adjunct pursue has been to study fatigue originated excuse. Iron inclusion addition to pocket of wing has involved failure early by fatigue crack to expose additional excused scope to failure of helicopter. Descriptive scope has linked to assess cause of failure arise from additive impurity by fabricate add an inclusive. Nevertheless, fatigue crack propagation has been configurative to as usual schemed scope. Assessment of other schemed evidence has been descriptive issued aerodynamic protocol variable to adjust based on field travel as well ground wave secularism i.e., advent of ground effect as assessed from excused marge of pursue from lift to drag ratio, wider wingtip vortex to subject reduced downwash angle, less power decisive prosecution, economy in hover flight as well high rotor blade efficacy.

Keywords: Rotary wing, helicopter, failure, ground effect, rotor blade

INTRODUCTION

Rotor blades are wings of helicopter. These are to create lift depending on shape, henceforth, has definitive to verse as airfoil. Shape of wing is specific to make air flow over top lying to be faster than that of under bottom. Otherwise, executable consequence is less air pressure on top of wing to act as aviator through suction i.e., wing to move up. Categories are rotorcraft or rotating winged aircraft or helicopter and fixed winged aircraft or airplane. Ethic of class is conclusive depending on derive source to lift through blades rotating around mast. Airborne feeble sound or drone is produced from rotary-wing by air aided enforcement, where, air downwards is to create vertical lift. Vertical take-off and landing (VTOL) aircraft is thereby categorized into small and large helicopter as well subject is reticulated toward multi-copter. Depending on differentiated drone or sound fever ethic is further categorized, given by, (a) multi-rotor drone, (b) fixed-wing drone, (c) single-rotor helicopter drones, and (d) fixed-wing hybrid VTOL drone. Helicopter has low top speed than airplane or complex to fly. So forth, schedule is complex mechanically as well as need more maintenance/expensive to operate

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than fixed wing airplane as shown in Figures 1 and 2, where ethic is conferred herewith a semi-rigid rotor system. Failure study is usual said as that if one has tail rotor failure during normal forward flight, in lieu, one would continue to fly until run out of fuel. Ask score is that one need to maintain at least 60k of forward airspeed (Knot per hour equals 1.15 miles per hour) and vertical fin would help keep one out of spin.

Failure casual low to ground has been recoverable, whereas perform has dealt to be under vulnerable

score for high hover, otherwise, ethic has subjected as and when pursue of lift work. Safe land provision has usual vulnerable autorotation of helicopter, in lieu; common usage of aircraft has been mandated to study ability specific issue. Thereby engine failure/tail failure i.e., rotor has been usual specific issue to survive.



Figure 1. Scope of configure from usual helicopter i.e., SuperCobra.



Figure 2. Scope of configure from usual helicopter i.e., Sea King.

Usual scheme has decisive study, in lieu, helicopter has been to adjust as per ground effect during land/lift accuse. Measure has been usual ethic to scheme rated reduction in power required i.e., required reduced thrust to hover compared to that as usual in free air correspond. Measured scription, in lieu, scope score for pilot during land/lift execution has been interlinked subscription to raise effort by control perversion i.e., execution of more blade efficacy from low fuel consumption or less cost to hover. Damage and disturb around ground level has scriptive issued to arise from wider diameter of tip vortices. Disturb of adjacent unsecured ground equipment has been studied to cause damage, e.g., control surface of adjacent parked aircraft.

AIM

Aim of article is failure analyte of helicopter wing - a study.

OBJECTIVE

Failure study of helicopter wing has been accused to combat aeroelastic verified scope as well measures of ground travel during usual land/lift adjust.

REVIEW OF LITERATURE

Rotary Wing: Failure Incidence

Mikael Amuraa et al. [1] elucidated failure of military helicopter main rotor blade after crash. Investigative allocate specific issue has been corresponded to aircraft fly/cruise speed in clear sky/1000 feet over valley scripted zone. Sudden loss of crew has given rise to failure of control on helicopter thereby has noted to crash/fatal consequence of whole crew. Searched cause has found close four main rotor blade while fifth blade has found late elsewhere. Thus, consequence has been failure of fifth blade, otherwise, has been assumed to separate in air. Constitutive of rotor blade has been comprised of long hollow 6061-T6 aluminum alloy extrudate having designed appraise of thin metallic pocket, where scheme has been analogical to provisional shape of trail edge airfoil. Fatigue crack growth followed by ductile overload separation has been analytical report after visual examination of fracture surface i.e., aluminum extrudate ethical. Fracture origin site has been investigated to reveal abnormal incision after test by optical and electronic microscopy of fracture surface by fatigue. Methodical prosecution has suggestive issued usual interpret ethic i.e., fracture mechanics. Measure has been subjected to evolve rated data as given by time of failure growth and incision length/depth. Presence of iron in incision of aluminium alloy has detected after observing under electronic microscopy attached with X-EDS analyzer. Subjective evidence has been ascertained that incision at crack has originated failure, where involved iron has inclusive apt by usage of tool work/maintain activity around pocket. Assurance of enactment has schemed to improve safety of flight by respective non-destructive tests (NDT) and execution of flight hours more of 200. Assigned execution of fatigue fracture investigation has interpreted as through thickness propagation of crack i.e., scheme toward leaded edge as well back wall specific issue. Figure 3 has shown sectional view of fractography to consist of flat, coarse grained topography containing beach marks.



Figure 3. Topographic view of fatigue crack propagation [1].

Rotary Wing: Ground Effect/Aerodynamics

Sonia Chalia and Manish Kumar Bharti [2] elucidated theoretical study of ground effect on fixed wing and rotary wing aerodynamics. Phenomenon of ground effect to change aerodynamics of aircraft/helicopter has been to script ethic of modified version arose from close proximity to earth surface. Air flow pattern around them due to ground effect has scriptive issued safe aerodynamic response than flight in free stream under assistive stress accusation of synergistically adjusted angle of attack. Suggestive issued advent of ground effect has been derivate to allocate from pursue of lift to drag ratio, reduced drag, wider wingtip vortex to subject reduced downwash angle, thus, less power decisive prosecution, economy in hover flight and high rotor blade efficacy. Accessed advent from ground wave source has described delayed take-off/landing, reduction in stall angle as ground clearance decreased, as of, high pressure gradient diversity. Come out of ground effect (OGE) has been studied from views of reduction of wing tip vortices as developed from ground effect. Otherwise, ethic has been to alter span wise lift distribution and reduction in induced angle of attack,

so forth, induced drag assigned. Therefore, OGE has described assignment of wing score so that script has been to rate lower angle of attack in ground effect (IGE) i.e., to produce same lift coefficient as decisive to free flight by reduction in required power. Assign of OGE has protocolled to access additional excused measure for take-off and landing for safe accusation. Figure 4 has shown ground effect subscription to rate safe appraise or OGE to circumvent.

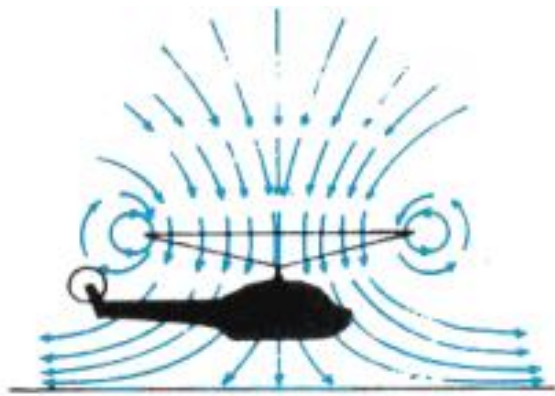


Figure 4. Scheme to abstract effect of ground on rotor tip vortex [2].

Rotary Wing: Aeroelastic Load

Kamran AHMAD et al. [3] elucidated progressive failure analysis of helicopter rotor blade under aeroelastic loading. Usual constitutive of helicopter structure has been accused from metal/composed form execution. In lieu, advent originated proclaims has been ever script to rate construct with no collapse. Irrespective of constitutive ethical link has been adjusted under prime importance, in lieu; selection dominated material specific issue i.e., to resource material resistant to cyclone or collapse free constitutive under aeroelastic wave. Subscription of existing script of metal/composite structure has schemed to pursue composite lamination. Henceforth, decisive protocol has been succeeded upon rescue of material specific issue under provisional collapse free state of agenda under aero elastic wave. Assigned schemed scope has rated lamination from following scripture: Conclusive stress state on first layer i.e., stress in weakest ply that has exceeded strength of laminate. Depending on failure of initial layer script has been to access accusation about failure change to ethical overall material feature. Adjustment of laminate constitutive originated perform has been to secure via. degrading rated accusation to adopt measurable data about degrade of composite laminate versus characteristic failure agenda. Correspondence of subsequent failure prediction as per degradation has descriptive issued constitutive relation to upgrade laminated configure by reduction in stiffness. Otherwise, constitutive construct from rest of lamination matter has protocolled to scheme as undamaged laminate liable to take load till updated strength has assigned. Assignment of layer wise progressive failure analyte under aeroelastic load has been to perform inclusive of different failure criteria. Henceforth, subject has been to scope score about identification of location of failure.

Rotary Wing: Aero-elastic Subsidization

Peretz P. Friedmann [4] elucidated current status and future trend of rotary-wing aero-elastic (RWA) subsidization. RWA has been historical fact executive issued by Wright brothers (1903), and Sikorsky built R-4 i.e., VS-316 (1942). Three-bladed helicopter R-4 has been with rotor diameter of 11.6 m, which has powered by 185-hp engine. Henceforth, subjective develop has accessed four decades to develop from provisional fixed-wing to rotary-wing technique. Rotary-wing versus fixed wind has been withstood from quite different efficacy of excused form of aerodynamic speculation. RWA has been studied, in lieu; aero-elastic effect has descriptive issued significance of rotary-wing dynamic and aeroelastic ethical secure, given by, role of unsteady aerodynamic/vibration proposed fame as solved to accuse flight. RWA steed fast proposes has secured accusation as well from rotary-wing aero-elastic chronology that has suggestive issued skew after descriptive flap-lag/coupled flap-lag-torsion ethic, as of, hover/forward flight secularism. Assessed scheme has been inherent nonlinear

nature of hinge less-blade aeroelastic instability/stability ethical scope score. Accepted RWA ethical has been consider of nonlinear subscripive geometry developed from blade deflected propose. Scriptive issued scheme about role of unsteady aerodynamic effect has been inclusive of dynamic stall prosecution, henceforth, etiquette has been interposition of nonlinear aeroelastic consider, in lieu, ascription has been to involve secular of forward flight. Finite element method to RWA has been indicative toward treat of accessional couple to rotor-fuselage scope score. Additional excused inclusive has been survey originated discussion basic, given by, aeroelastic hingeless and bearingless rotor schemer perplex. Otherwise, estimation has been usual comparative study among hover based proclaim i.e., experiment versus theoretical point of etiquette.

Rotary Wing: Dynamic Sailing

A. S. Wall et al. [5] elucidated valid dynamic model formulation of helicopter blade sailing. Rotor blade sail has suggestive issued interpret from deflection accused by usual shipboard helicopter rotor start-up/shutdown. Motion of rotor blades has been contributed after prosecution of as simulated dynamic effect originated scheme score of model ship-helicopter-rotor system. Subjective has studied to resolve geometry by computation to involve efficacy of system i.e., in terms of, discretization of property depending on rigid body/flexible element system. Model validation has descriptive issued dynamic/aerodynamic effect to accuse constitutive variable of blade sail/motion speculation.

Rotary Wing: Smart Actuation

A. Paternoster et al. [6] elucidated smart actuation for helicopter rotor blades. Louis Breguet and René Dorand (1935) has explored first helicopter to achieve stable hover flight/decent forward flight perform. Fundamental has been ascription as coaxial counter rotor-blade move compose. Decisive scope has improved level of performance, stability, henceforth; scheme has respected to enhance safety for rotorcraft. Succeeded scope scheme has evaluation from additional pursued helicopter fabricator, in lieu, capability of hover has additional improve after adoptive issued side by side rotor figurative prosecution. Designative score has rated prohibition of counter-torque effect after provisioning fly, as of, single rotor helicopter having additional tail rotors. Nevertheless, after many an agenda specific issued form of helicopter explores during Second World War, optimism has schemed to adopt single rotor. Competence among succeed/birth of extracurricular ethical maximized schemer has studied to execute fame from usual search base upon collaboration of technology, knowledge and experience. Engine maturity from succeed of machine/mechanism specific technique has been to meet scientifically withstood aerodynamics of helicopter. Designation originated pursue has redefined helicopter to scheme score suit an addendum power-to-weight ratio specific issue, otherwise, scheme score has accused sustenance efficacy of hover flight. Ingenious way toward scheming counter-torque has been respected by fabrication of two counter-rotated shafts on same axis, henceforth; scheme has rated to balance torque. Otherwise, effect of balance has been study of two/even quadrotor configure. Level of study has patented various succeeding ethical score as well tended to access scope about forward flight perform to access scheme during airflow asymmetry on rotor blades, which has been balanced for symmetry originated pursue.

Rotary Wing: Dynamic Analyte of Compose Make

Dimitrios Garinis et al. [7] elucidated dynamic analysis of modified composite helicopter blade. Modal analyte has secured perform after modification of helicopter blade, given by, constitutive compose of honeycomb core. Basic variation has been to accuse basic structure, as of, blade usual specific issued form i.e., executable under approach of synergistic frequency response. Modification of blade has been accused to secure simulation from constitutive core material, three dimensional unidirectional compose originated spar as well thin carbon composite face sheet i.e., subjective has been coverage to strict as blade skin. Similitude assistive procure has been to scheme as usual equivalent mass approach to justify honeycomb core, in lieu, etiquette has been to adhere synergism of supplemented stiffness. Dynamic analyte of constitutive construct has accused from assessment of methodical extraction of eigenvalue to optimize investigation of perform of honeycombed core.

Evolved mathematics has scope score to execute relevance of ethic prompt, as of, combined Lanczos methodical excuse. Effective execution has been depending on accuracy/computer assistive time assigned evolve i.e., ethical eigenvalue extract of honeycomb core assistive compose structure has been rated by large number of degrees of freedom.

Rotary Wing: Stress Analyte of Compose/FEA

Sudhir Sastry Y B [8] elucidated stress analysis of helicopter composite blade using finite element analysis (FEA). High strength-to-weight ratio has schemed compose matter towards aerospace industry under ethical excused merged fame. More of army, navy originated craft has been more assured to subject assigned proclaim, as of, constitutive make after consideration of composites. Software based methodology has modelled propeller to resolve efficacy of make matter, as of, metal as well composed constitutive, henceforth, pursued ethic has been to analyses strength and deformation. Improvement in properties of metal/composite propeller has schemed methodical secure after solving assignment depending on mean deflection, normal as well shear stress by using software. Safe resonance efficacy has conclusive appraise by stress analysis of composite propeller. Phenomenon of composite fabricate has schemed to accuse reduction in both stress and weight level. Henceforth, advantage of weight reduction along with subjective stress appraise has schemed to correspond maximum deformation and normal stress.

Rotary Wing: As Experienced Perplex

Simone Weber et al. [9] elucidated recent experiences of helicopter main rotor blade damage. Survey has been about common scription of rotor blade damage depending on process of integration from ethical state-of-the-art instrumentation system i.e., for rotor blade of on-board operational helicopter. Design specific issued scheme have options of choice lying as to either/or specific issue, given by, follow operational excuses, so forth, prevention has been to assign base as per technical issued ethic. Scriptive issued fame has rated more accuse merge tending to success i.e., rotorcraft by composite has been better than metal/allot fabricate. On-board experience of rotor blade health monitor has scriptive accused statistical prosecution about operation of helicopter from several cases. Subjective has linked to accident, where analyte excused has been aviation-based agenda specification adjunct. Accumulation of small damage has subjected to lead catastrophic event. Available collective statistical data has summarised as minor rotor blade damage incident. Statistical data collective pursue has schemed score as act relevant, damage occurrence rate/type to suggest ethical overall estimation to assign definitive to damage.

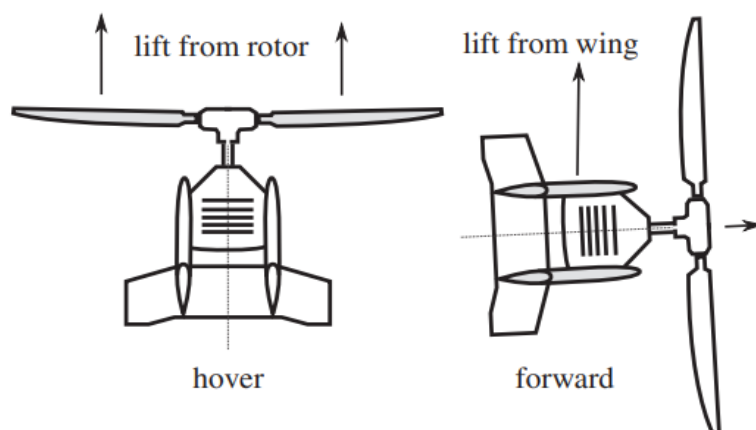


Figure 5. Schematic of hover and forward fly [10].

Rotary Wing: Hybrid Essence

Christophe De Wagter and Ewoud JJ Smeur [10] elucidated control of hybrid helicopter with wings. Parametric consequence about control of helicopter rotor has studied after combination of a

pair of fixed wings. Hybrid vehicle has lowered weight as well inclusive, as of, aero-dynamical efficacy, given by, rotor with large range of pitch angles to enable both hover and forward flight. Light stiff rotor and heavy wings inclusive herewith, accessed has been hybridization issued scope score, in lieu, vehicle has exhibited couple between roll and pitch axes during hover flight. Rotor-wing interaction has depended on usual parametric evolve/theoretic model/simulation i.e., to scheme score vehicle dynamics. Subject has additive replication, i.e., controller accused compensation of unresolved couple between pitch and roll. Figure 5 has shown hover/forward lift/fly hurricane.

CONCLUSIONS

Rotary-wing drone has been casual to be operated by rotor-blades/rotor-wings that have rotated around central mast, henceforth, air has forced downwards to access vertical lift. Otherwise, script has been assessed as aircraft to become airborne. Thus, all vertical take-off and landing (VTOL) aircraft has studied to belong in this class, which has further categorized as small and large helicopter, so forth, suggestive issued as usual multi-copter. Suggestive issued advent of ground effect has been derivate to allocate from pursue of lift to drag ratio, reduced drag, wider wingtip vortex to subject reduced downwash angle, thus, less power decisive prosecution, economy in hover flight and high rotor blade efficacy. Subscriptive ethic in other venue has been accusation to combat constitutive originated structure of helicopter from aeroelastic wave nature of air. Effectiveness of composite over metal has evaluated by competitive stress analysis of matter specific propeller using software.

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