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Landing Gear of an Aircraft Structure: A Review

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***Abstract*—The landing gear system of an aircraft is a system. It also absorbs the energy from the impact of landing Numerical type simulation has become highly invaluable tool for the assessment of the landing gear type dynamics also as well as of aircraft landing structure gear interaction. This paper also describes the normal structure review of a simple landing-gear structure model system, and which is accurately simulates with the energy system absorbed by the gear without the adding substantial structure and complexity with the model. it carries the structure aircraft weight at all require ground operations, including, landing, take off, taxiing, and towing. In future we know that advances in computational type speed have made aircraft and high spacecraft crash simulations design using an explicit, transient type dynamic, finite element analysis (FEM) code are the more feasible. For a plane crash model type system the landing gear is also exact response is approximated work with a many strong spring where many different force applied to the different fuselage. And it is also computed in a user-written works type. Helicopter crash type simulations which is using this approach that are compared with different necessary data is also acquired with the experimental method and data from a full structure crash structure test can be achieved by with the use of an aircraft of a composite. Depends on type of landing gear systems is also presented. Specifically, a nonlinear type model can easily developed which is simulated, and against static and dynamic data test data. Many type model includes nonlinear structure effects such as a velocity type squared related high damping, poly tropic gas law, stick-slip friction, a geometry governed with the high model structure for the high discharge type coefficients and methods, effects a nonlinear spring and damping model structure.**

Keywords—Landing Gear; Simulation; Analysis; Finite Element Monitoring; Technologies

I. INTRODUCTION

One of the issues confronting from the aircraft industry is landing gear apparatus reproduction, simulation and design and analysis, particularly shimmy and rigging type gear, brake induced vibration structure. Although neither shimmy nor gear brake incited vibrations framework structure are typically cataclysmic, circle framework they can lead to accidental condition because of unnecessary weight, wear and shortened existence of apparatus parts and structure and add to pilot and passenger discomfort . Recently, space science agency has started a push to build the safety by a component of diverse many years. This security activity has prodded a numerous enthusiasm for enhancing landing rigging outline framework to minimize brake-instigated vibration that are still generally misunderstood phenomenon . Keeping in mind the end goal to summaries of these issues. The significant center of the proposition is to condense work recorded from the diverse years to highlight the most recent landing gear in taking care of these vibration issues in aviation. Paper described a variety of design, testing, crash testing, aircraft modeling, and simulation of aircraft landing gear structure. Characterization and required validation and of shimmy and highly brake-induced vibration system of aircraft landing gear are also reported with many goal. [1] Based on a nonlinear structure model of the mechanics of the landing gear system and different elasticity according to elastic string type theory, some industries well-known linear and nonlinear mathematical methods system are applied to the shimmy analysis system of a simple model of a nose type gear. [2] The landing gear is an important system for the aircraft. It also absorbs the energy of the landing impact that is related to the ground and operations, It including take off, taxiing, and towing structure. Numerical simulation has become an invaluable important tool for the assessment of landing gear system as well as of aircraft/landing gear interaction. [3]

Recent advances in different computational type speed have made an aircraft and spacecraft crash structure and its simulations using an explicit, and nonlinear, transient-dynamic system. Finite element analysis (FEM) code more important feasible. FEM gives the development of a simple type landing-gear model structure, which accurately simulates the energy which absorbed by the gear system without adding substantial type Complexity to the model. A crash model that the landing gear response is require approximated with a spring structure.

Where the force applied to the engine fuselage is also computed in a user-written type subroutine. Aircraft and Helicopter crash simulations using this approach are compared to and also it is necessary with the previously acquired experimental type data from a full-scale type crash test of a composite manufactured helicopter. [4]

It is important to decide static and element ground loads for the aircraft structure ground moves precisely in the outline design stage. Simulation of the critical operational cases is a better route that contrasted with the tests on real aircraft to the large examine these heaps at a sensible expense. In this work, the simulation and reproduction of landing gear and ground moves for different transport carrier is can be introduced and better route that contrasted with the tests on real aircraft to the large examine these heaps at a sensible expense. In this work, the simulation and reproduction of landing gear and ground moves for different transport carrier is can be introduced and presented. The flying machine models can be manufactured by the multibody multiplication, reproduction device SIMPACK. The model realized in joins horizontally even components of the model. Cornering, burden runs and pushback are as ordinary ground moves. For entertainment of braking, a fundamental However correct Antilock Braking System (ABS) calculation is essential. [5] Shimmy vibration is a fundamental and essential for the development in the landing gear structure either the Takeoff or landing of an aircraft and flying machine. This sort of vibration is given from the dynamic phase of the forward development of the airplane. In this manner, this conditions begins a restraint empowered sort of vibration in the wheels that may achieved. An alternate attempt is made to add to a dynamical structure model for the air nose rigging to investigate its transient response for the parallel deviations and shimmy edges. [7] For the examination of adaptable flexible turning and twisting of the landing aircraft of a flying machine under element loads after landing and resulting braking and roll out, a MBS-based model of the landing gear is described and presented. To separate impacts of the flexible bending of the principle arrival adapt by the fuselage is viewed and considered. Also with performing a flare with the flying machine and aircraft can be achieved by method for an antiskid framework. [8] The previous thirty years have seen critical significant reduction in plane clamor through the appropriation of high-bypass-ratio proportion turbofan engines on common flight transports. Some time ago different sources, for example, the airframe have now turned into toward commotion accreditation and ecological considerations. [10] Airframe noise is most important with flying machine approach and landing, when motors are working at push with the high-lift gadgets and landing apparatus conveyed. Wind passage tests and fly-over estimations have uncovered the main edge supports, fold edges, and the arrival apparatus to be the significant to airframe clamor. With the necessities of expanded weight and sink speed in air ships outline, the heaps on airframes and landing rigging increment correspondingly. This issue is particularly the case amid bearer plane arrivals on decks and even space transport arrivals [11]

Landing gear is an undeniably huge commotion source on large airplane as other clamor sources are reduced. On the biggest flying machine, it can be the overwhelming wellspring of commotion with the arrival approach. Impressive work has been done to reduce the effect of apparatus commotion. [11] [12] Airframe adaptability and the versatile properties of tire are two fundamental issues considered in the arrival rigging displaying to the exact portrayal of the shimmy phenomena.[6] at the end of the day, just a genuinely finished model of the structure including the tire properties could appropriately assess the steadiness of the arrival gear framework. [12-15] the idea of the double output drive could be stretched out to incorporate three or more consecutive capacities in future frameworks.

A. Remote electronic Unit

According to application of a different Remote Electronic Unit will also provide a high different integrity and command with the monitoring system and interfacing to various high feedback to position with sensors also providing appropriate demands to the dual-output Motor Control system Unit [16]

B. Computer Simulation and design

Computer related simulations are continuously being developed by the study of this disturbance type transmission and problem. The task is also to take information by concerning gear dynamics structures, fuselage and its dynamics, structure runway profile, with taxi speed, to develop a high simulator for predicting aircraft structure ground landing response. Simulation of the landing gear dynamics can be the subject of much high research for many of the years. The military is long been interested in simulating structure gear to response to the repaired, bomb can be damaged runways. We know the great high deal of the effort can be applied by the problem of different determining can how the well to the repair of a runway that to prevent a landing gear failures. This type of effort did not focus on the changing of the gear, but rather we can be due on changing the runway structure type repair specifications. Active type control structure concepts that render aircraft landing gears less landing sensitive to rough runways with decreasing the time evolution that can be needed to repair the damaged runways structure, and thus it allowing the quicker response of the military missions. [18]

C. Failure analysis of the landing gear and apparatus

Weariness, corrosion, fatigue were observed to be the primary components and mechanisms. Weariness fatigue happened for the most part in steel components while corrosion happened for the most part with aluminum combination compounds and wheels. Not very many over disappointments were noted. Diverse disappointment were a reasons were recognized. Plan structure lacks and assembling imperfections drove predominantly to fatigue while poor material choice and improve its field upkeep were the principal starting points of corrosion related failures. Thus, a series of preventive measures was either prescribed or re-stressed. While weariness and fatigue can best be tended to by enhancing the nature of assembling and by better describing in-service and assembling and by, much work

stays to be done on the time-dependent with the degradation process and their synergism with fatigue, as consumption has regularly been neglected in both the configuration, design and testing stages and additionally in the support domain. [21] Despite the broad arrival landing gear outline, design and tests completed by the fashioners and the large makers, and the huge number of inconvenience with travel free arrivals accumulated by the users, the Canadian Forces (CF), and also others, have experienced a large scope of issues or range a disappointments with landing gear systems.[19][21]

II. FINITE ELEMENT ANALYSIS OF AIRCRAFT LANDING GEAR

FEM (Finite component Monitoring) utilizing the contact capacities has been utilized to model tooth avoidances and contact examples between both metallic and non-metallic gear. The initial phase in assessing tooth diversion, deflection and hence load sharing is to demonstrate the model tooth contact. Since, the FEM reproduces the real cross section of the tooth, it can be utilized to decide burden offering to assembling mistakes. At long last, the greatest twisting anxieties can be resolved. For forecast of the torsional network solidness three its stages were considered: investigation with incomplete teeth models, examination with single-tooth apparatus models, and investigation of multi teeth gears over a complete cross section cycle. The expectation of gear element loads and it is dependably a noise before you start to for the substance as a different content document. Concern in gear outline design. These elements are identified with the gear transmission mistake which is characterized as the distinction between the positions that the yield shaft of a gear drive would have if the gearbox was great. The transmission mistakes are brought about by the tooth geometry blunders, versatile disfigurements, and flawed mounting. Extraordinary limited components have been created to model twisting, and torsional disfigurements where different sorts of assembling structure and gathering of the apparatuses are considered. The contact connection between two gear the produces mechanical loads between associating bodies that can influence their working conditions. The recognizable proof of the contact locale is the initial phase in contact investigation issues. A contact identification calculation relies on upon the limit estimate of contact questions and can be for instance, straight lines between hubs, limited component shape capacities, spline capacities or uncommon procedures (i.e. pinball calculation). The outline of riggings comprises as a rule of two sections: worldwide and nearby (tooth geometry) apparatus plan. The outline of the nearby tooth geometry is imperative. The shape, size and position of the contact spot are the central point in giving smooth operation of the rigging pair. Where the FEM is a powerful investigation instrument, will give sensible results to the rigging conduct. To upgrade the exactness of the examination a rehashed effect brought about by element variances of the apparatus torque can be considered. The heap conveying limit and administration life are the essential prerequisites in the configuration of riggings. There are four primary disappointment modes in gear frameworks: tooth bending weariness, contact fatigue, scoring and surface wear. The learning of the affectability of configuration parameters and assembling mistakes on wear is urgent for the fashioner. The immediate material loss prompts to functional failure and additionally to change in vibration and noise attributes. The load limit of a gear framework is mainly restricted by the bending quality. The gears are required to have a high-fatigue quality and effect load limit frequently together with the request on the reduction of size and weight. Managing crack mechanics contemplates, where the FEM has been actualized, have been distributed and are recorded in the Appendix. Fatigue break development has been simulated. [20]

III.RELATION OF SIMULATION WITH EXPERIMENTAL DATA

The examination of shear stress lines in surface oil in what capacity can provide connection and on three-dimensional development about which how information are frequently difficult or time consuming. This method, in conjunction with mean surface weight information, was used to decide the surface topology on a fore and toward the back wheel of a four-wheel landing gear model.

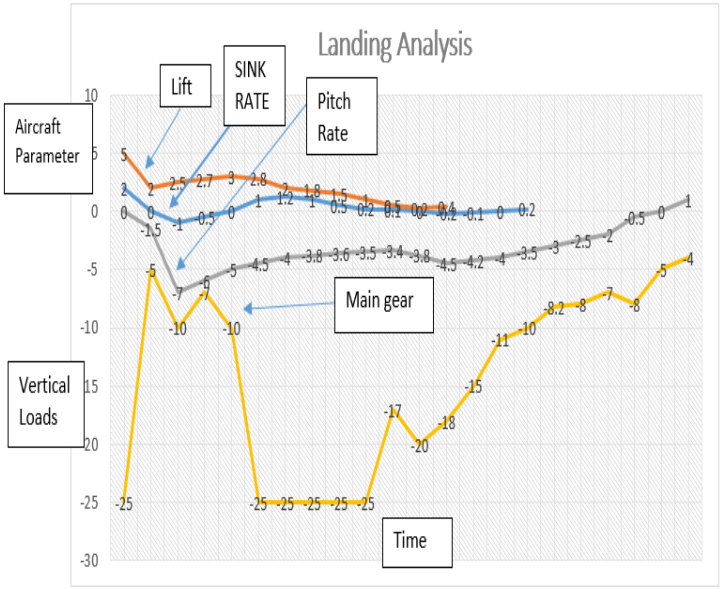

Figure- 1 landing brake analysis system chart in Aircraft parameter and Vertical Loads

Tests were performed at a Reynolds number of 6£105 taking into account wheel measurement. Since structure is created when joins to or isolates from a surface, the nitty gritty examination highlights locales on the wheels where further examination may be justified. The surface attributes on the wheels decided in this study associate well with the mean how information procured in a past study. A relationship is theorized between watched changes in the condition of partition on the ground side of the all-wheel in the present and study, with the changing stream astute area of a mid-wheel vortex found in a past study. [22]

The unbending fuselage crash. Limited component model will be executed. The simulation results required about one hour CPU time on a Sun Ultra 450workstation and during the sun ultra process it complete the 0.100-sproblem time. [4] The precision of the reproduction results was experimental through relationship with the trial succession of occasions and the speeds at particular areas. Characterized in the anticipated spring powers speaking to the arrival landing gears, which were connected to the fuselage model. Substantial strengths are at first experienced as a consequence of the high speed differential. The power of the fundamental arrival rigging is evacuated at the season of the fuselage impact, 0.095 s. The substantial starting powers for the fundamental apparatus are not be physical.

These vast powers did not altogether influence the inflexible fuselage reaction, apparently in light of the brief length of time. The simulation sequence of occasions was resolved from the landing gear power. The test times depended on analysis of the rapid. General the relationship is great without any than 4 ms mistake. The more drawn out time between the left and right rigging contact for the recreation could be normal in light of the improved landing apparatus approach. [4]

IV. LANDING GEAR- SOILS INTERACTION ANALYSIS

The determination of aircraft landing flotation and operation capacity on semi-and unprepared equipped soil runways is a basic variable in creating forward zone landing gear. Restricted fighting circumstances. An examination was led essentially impact aircraft execution Analysis of accessible test drag-sinkage-speed information prompted the characterizing of no less than three unmistakable areas for which the sinkage proportion speed relationship demonstrates a particular reaction. A drag proportion sinkage proportion mathematical statement was created for use in one of these speed districts.

V. EXPERIMENTS AND ANALYSIS FOR AIRCRAFT LANDING GEAR

Transport aircraft are arranged with information frameworks for hardware, flight controls, and other basic subsystems. As, an expanded emphasis has been put on the potential for utilizing these information capacities, in conjunction with rising sensor and innovations for checking of flying machine condition during flight. The potential advantages of fiber optic sensors include the capacity to access limited or shortened areas where it is hard to investigate and also permitting a circulation of sensors at areas around the aircraft. Be that as it may, so these dark structure, it was important to adjust the framework to the extreme environment experienced in regular operation of transport aircraft. A specific test was to arrange the sensors for operation on aircraft parts that experience development or turn during use. [54][60] Twenty-six Fabret-Perot Interferometer strain sensors and two long period grinding (LPG) moisture sensors were introduced on the principle gear assembly. Sensor areas are condensed in figure. The strain readout frameworks were prepared to do either simple or advanced digital to a PC for 5 channels, but it is the (24 MUX-8) switched type channels also capable of only digital type output. The gear was subjected to cyclic structure loading using a full-scale shaker type table apparatus at NASA Langley Research Center. [24]

VI. ANALYSIS OF ACOUSTIC EMISSION SIGNALS FROM DIFFERENT LANDING GEAR COMPONENTS

This work structures a portion of a bigger examination concerning split location utilizing acoustic outflow (AE) amid landing apparatus airworthiness testing. It concentrates on the utilization of key part examination (PCA) to separate between weakness split engendering (FCP) signs and elevated amounts of foundation commotion. A simulated AE crack source was produced and also five sources were utilized to create contrasting manufactured AE signals. Signs were recorded from each of the six fake sources in a genuine landing rigging part subject to no heap. [27] This extend past work utilizing essential part examination (PCA) of AE highlight information [29-30] for sign discrimination. PCA is a technique used to streamline high-arrange information sets to lower measurements to permit a basic investigation. Basically the information are analyzed in multi-dimensional space and the two bearings of most prominent difference (not as a matter of course in accordance with any of the information measurements), or the vital parts, are recognized. The information are then displayed as a two dimensional x–y plot as far as the two key segments. The foremost segments are distinguished utilizing the philosophy laid out underneath. [28]

A. Experimental Procedure for test of landing gear Aircraft

With a specific goal to survey the capacity of the PCA strategy to recognize signals from FCP sources and noise in an arrival rigging structure, an artificial FCP source was composed. This was fundamental in light of the fact that the prerequisite for landing apparatus segments to not add to any weakness breaks during a crack flexibility test implies that genuine cracks are an uncommon event. During a past examination utilizing minimized strain (CT) examples, signals from genuine FCP sources were gathered. [5] Using another undamaged example, with an indistinguishable AE set-up, signs were beat utilizing a physical acoustics wave generator at the break area and the reaction observed. [27][28] The yield of the wave generator was balanced until they got flag firmly coordinated the beforehand recorded FCP signal. Five further flags were made discretionarily to reproduce different sources with a specific end goal to evaluate the capacity of the PCA procedure to recognize different sources. It displays the element information of two signs recorded from CT examples, one from a genuine weariness crack source and the other from the simulated FCP source. At first look, the component information of the two signs don't have all the marks of being fundamentally the same; on the other hand, if the qualities are viewed as with respect to the full scope of highlight information qualities recorded during a test then the distinctions don't appear to be so huge. Rise time, adequacy are all thought to be fundamentally the same and in spite of the fact that not as

firmly coordinated, length of time are still thought to be comparative with respect to their most extreme extents. Higher distinction was seen in the length of time from
a more extended ring down of the counterfeit sign; be that as it may, any adjustments made to remedy this created other element information to modify. It gives elements of the used to deliver the manufactured FCP source, marked thunderous sensors were connected to an arrival gear trimmer connection segment Ultrasound gel was utilized to couple the sensors to the surface while attractive clasps were utilized to hold the sensors in position. A further beating source was connected to the structure between sensors 1 and 2 and is utilized to info of signs into the structure. [27] One from a real fatigue fracture source and the other from the artificial FCP source. At first glance, the feature data of the two signals do not appear to be very similar; however, if the values are considered relative to the full range of feature data values recorded during a fatigue test then the differences do not seem so large. Rise time, amplitude and initiation frequency are all considered to be very similar and although not as closely matched energy, duration and counts are still considered to be similar relative to their maximum ranges. Higher difference was observed in the energy, duration and counts values from a longer ring down of the artificial signal; however, any alterations made to correct this caused other feature data to alter. It provides details of the pulse used to produce the artificial FCP source, resonant sensors were attached to a landing gear trimmer link component Ultrasound gel was used to couple the sensors to the surface A further pulsing source was attached to the structure between sensors 1 and 2and is used to input of signals. [27]

VII. CORROSION FATIGUE AND THERMO MECHANICAL FAILURES OF AIR CRAFT LANDING GEAR STEEL

300M steel is broadly utilized as a part of flying machine landing gear in light of its one of a kind blend of quality and break strength, yet is defenseless against foreign object damage (FOD), consumption fatigue, and stress corrosion fatigue (SCC) disappointments with conceivably disastrous outcomes. The exhaustion, erosion weariness in salt water, and SCC execution of LPB prepared 300M steel was contrasted and shot peened (SP) and low stretch ground (LSG) conditions. LPB, with and without reproduced FOD, created profound leftover pressure that drastically enhanced both the HCF and erosion weariness quality. The exhaustion quality of LSG and SP treated surfaces was definitely it can be decrease by all type of salt structure and FOD presentation with no noticeable continuance limit for erosion weakness conditions. SCC testing of LPB treated landing apparatus segments at 1030 to 2270 MPa (150 to 180 ksi) static burdens was ended after 1500 hrs. without disappointment, contrasted with disappointment in as meager as 13 hours without treatment

A. Thermomechanical properties of aircraft landing gear

A methodology for studying the characteristic thermal response of a landing gear shock absorber is exhibited. Rough runways induce high loads on the shock absorber bearings and because of high relative type sliding and it's high sliding speeds of the shock absorber piston, heat is dissipated which is known to have led to structural damage. In this paper, an overall model has been developed that is used to outline the characteristics of the thermal behavior in the landing gear shock absorber. The developed thermo-tribo-mechanical model which is TTM model is subdivided into four parts, all using simplified but representative equations. Emphasis is placed on developing methodologies a framework and studying the evolution of the average temperature in the TZI (thermal zone of interest) while taxiing and taking-off. [26]

VIII. CONCLUSION

An inventive landing gear modelling methodology is depend in a crash simulation of a full-scale accident test of a composite helicopter. The simulation procedure was using the basic arrival gear model with an unbending and exact model. Helicopter crash design and simulation utilizing this methodology were contrasted and procured test information from a full-scale accident test of a composite helicopter. The accompanying conclusions will be accomplished come to if the project will effectively finished The landing gear demonstrating, design and modelling will be approach precisely recreated with the extent and introduction of the landing gear power on the model. The utilization of an unbending rigid model for a part of the simulation will be suitable and brought about critical lessening of CPU time for the aggregate accident recreation and examination.

In synopsis, the arrival landing gear model will be fruitful at approximating the impact of the stroking without adding significantly to the model unpredictability. This rearrangements in conjunction with the inflexible model assumption can bring about huge significant reduction in time.

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REFERENCES

[1] Pritchard, J. (2001). Overview of landing gear dynamics . Journal of aircraft,38(1), 130-137.
[2] Somieski, G. (1997). Shimmy analysis of a simple aircraft nose landing gear model using different mathematical methods. Aerospace Science and Technology, 1(8), 545-555.
[3] Krüger, W., Besselink, I., Cowling, D., Doan, D. B., Kortüm, W., & Krabacher, W. (1997). Aircraft landing gear dynamics :simulation and control. Vehicle System Dynamics, 28(2-3), 119-158.
[4] Lyle, K. H., Jackson, K. E., & Fasanella, E. L. (2002). Simulation of aircraft landing gears with a nonlinear dynamic finite element code. Journal of Aircraft,39(1), 142-147.
[5] Khapane, P. D. (2003). Simulation of asymmetric landing and typical ground maneuvers for large transport aircraft. Aerospace Science and Technology,7(8), 611-619.

[6] Esmailzadeh, E., & Farzaneh, K. A. (1999). Shimmy vibration analysis of aircraft landing gears. Journal of Vibration and Control, 5(1), 45-56.
[7] Esmailzadeh , E., & Farzaneh K. A. (1999). Shimmy vibration analysis of aircraft landing gears. Journal of Vibration and Control, 5(1), 45-56.
[8] Lernbeiss, R., & Plöchl, M. (2007). Simulation model of an aircraft landing gear considering elastic properties of the shock absorber. Proceedings of the Institution of Mechanical Engineers, Part K: Journal of Multi-body Dynamics,221(1), 77-86
[9] Li, F., Khorrami, M. R., & Malik, M. R. (2002). Unsteady Simulation of a Landing-Gear Flow Field. AIAA paper, 2411, 2002.
[10] Lockard, D. P., Khorrami, M. R., & Li, F. (2003). Aeroacoustic analysis of a simplified landing gear. AIAA paper, 3111, 2003.
[11] Keating, A., Dethioux, P., Satti, R., Noelting, S., Louis, J., Van de Ven, T., & Vieito, R. (2009). Computational aeroacoustics validation and analysis of a nose landing gear. AIAA Paper, 3154, 2009.
[12] Wei, X., & Nie, H. (2005). Dynamic analysis of aircraft landing impact using landing region based model. Journal of aircraft, 42(6), 1631-1637.
[13] Quayle, A. R., Dowling, A. P., Babinsky, H., Graham, W. R., & Sijtsma, P. (2009). Landing gear for a silent aircraft (Doctoral dissertation, University of Cambridge).
[14] Dole, G. R. (1986). A review of computer simulations for aircraft - surface dynamics. Journal of Aircraft, 23(4), 257-265.
[15] Fallah, M. S., Long, S. H., Xie, W. F., & Bhat, R. (2008). Robust model predictive control of shimmy vibration in aircraft landing gears. Journal of Aircraft, 45(6), 1872-1880.
[16] Wijekoon, T., Empringham L., Wheeler P. W., Clare, J. C., Whitley, C., & Towers, G. (2009, February). Aircraft electrical landing gear Actuation using dual-output power converter with mutual power circuit components. In Applied Power Electronics Conference and Exposition, 2009. APEC 2009. Twenty Fourth Annual IEEE (pp. 1263-1268). IEEE.
[17] Wen, Z., Zhi, Z., Qidan, Z., & Shiyue, X. (2009). Dynamics model of carrier-based aircraft landing gears landed on dynamic deck. Chinese Journal of aeronautics, 22(4), 371-379
[18] Daniels, J. N. (1996). A method for landing gear modeling and simulation with experimental validation (Master's thesis, George Washington University
[19] Kilner, J. R. (1982). Pneumatic tire model for aircraft simulation. *Journal of Aircraft*, *19*(10), 851-857.
[20] Prášil, L., & Mackerle, J. (2008). Finite element analyses and simulations of gears and gear drives: A bibliography 1997-2006. *Engineering computations*,*25*(3), 196-219.
[21] Freymann, I. R. (1991). Actively damped landing gear system. *AD-A239 914*, 16.
[22] Prevey, P., Jayaraman, N., Ontko, N., Shepard, M., Ware, R., & Coate, J. (2004). *Mechanical Suppression of SCC and Corrosion Fatigue Failures in 300M Steel Landing Gear*. LAMBDA TECHNOLOGIES CINCINNATI OH.
[23] Kraft, D. C. (1968). *ANALYTICAL LANDING GEAR-SOILS INTERACTION-PHASE 1*. DAYTON UNIV OH RESEARCH INST.
[24] Munns, T., Palmer, M., & by Institutions, F. (2005, August). Health Management Technologies and Experiments for Transport Aircraft Landing Gear. In *AIAA Guidance, Navigation, and Control Conference and Exhibit* (p. 6355).
[25] Earl, T. D. (1967). *Air Cushion Landing Gear Feasibility Study* (No. D7233-945001). BELL AEROSYSTEMS CO BUFFALO NY.
[26] Heirendt, L., Liu, H. H., & Wang, P. (2012, November). Characteristic Aircraft Landing Gear Thermo-Tribo-Mechanical Model. In *ASME 2012 International Mechanical Engineering Congress and Exposition* (pp. 1743-1748). American Society of Mechanical Engineers.
[27] Eaton, M. J., Pullin, R., Hensman, J. J., Holford, K. M., Worden, K., & Evans, S. L. (2011). Principal component analysis of acoustic emission signals from landing gear components: an aid to fatigue fracture detection. *Strain*, *47*(s1), e588-e594.
[28] Lopes, L. V. (2009). *A new approach to complete aircraft landing gear noise prediction* (Doctoral dissertation, The Pennsylvania State University).
[29] Rippengill, S., Worden, K., Holford, K. M. and Pullin, R. (2003) Automatic classification of acoustic emission patterns. J. Strain 39, 31–41.
[30] Manson, G., Worden, K., Holford, K. M. and Pullin, R. (2001) Visualisation and dimension reduction of acoustic emission data for damage detection. J. Intelligent Mater. Sys. Struct. 12, 529–536.
[31] Wittlin, G. (1983). Analysis of aircraft dynamic behavior in a crash environment.Journal of Aircraft, 20(9), 762-769.
[32] Lazos, B. (2002). Surface topology on the wheels of a generic four-wheel landing gear . AIAA journal, 40(12), 2402-2411.
[33] Murayama, M., Togashi, F., Nakahashi, K., Matsushima, K., & Kato, T. (2005). Simulation of aircraft response to control surface deflection using unstructured dynamic grids. Journal of Aircraft, 42(2), 340-346.
[34] Hwang, J. H., & Kim, J. S. (2000). On the approximate solution of aircraft landing gear under nonstationary random excitations. KSME international journal, 14(9), 968-977.
[35] Filippone, A. (2010). Theoretical framework for the simulation of transport aircraft flight. Journal of Aircraft, 47(5), 1679-1696.
[36] Brooks, D. K., Waun, C. M., & Gross, L. E. (1992). U.S. Patent No. 5,111,402. Washington, DC: U.S. Patent and Trademark Office.
[37] Black, R. J. (1982, September). Application of tire dynamics to aircraft landing gear design analysis. In NASA CP-2264, Workshop on" Tire Modeling," at Langley Research Center (pp. 71-93).
[38] Jenkins, S. F. N. (1989). Landing gear design and development. Proceedings of the Institution of Mechanical Engineers, Part G: Journal of Aerospace Engineering, 203(1), 67-73.
[39] Elmore, K. L., McCarthy, J., Frost, W., & Chang, H. P. (1986). A high resolution spatial and temporal multiple Doppler analysis of a microburst and its application to aircraft flight simulation. Journal of climate and applied meteorology, 25(10), 1398-1425.
[40] Sura, N. K. (2007). Lateral Response of Nonlinear Nose Wheel Landing Gear Models with Torsional Free-play. Journal of Aircraft, 44(6), 1991-1997.
[41] Prevey, P., Jayaraman, N., Ontko, N., Shepard, M., Ware, R., & Coate, J. (2004). Mechanical Suppression of SCC and Corrosion Fatigue Failures in 300M Steel Landing Gear. LAMBDA TECHNOLOGIES CINCINNATI OH.
[42] Wijekoon, T., Empringham, L., & Wheeler, P. (2009, November). Dual-output motor control unit for an electromechanically actuated nose landing gear. InIndustrial Electronics, 2009. IECON'09. 35th Annual Conference of IEEE (pp. 2563-2568). IEEE.
[43] Knowles, J. A., Krauskopf, B., & Lowenberg, M. (2013). Numerical continuation analysis of a three-dimensional aircraft main landing gear mechanism.Nonlinear Dynamics, 71(1-2), 331-352.
[44] Ottens, H. H. (1982). Predicted and measured landing gear loads for the NF-5 aircraft taxiing over a bumpy runway. Nationaal Lucht-en Ruimtevaartlaboratorium.
[45] Sura, N. K., & Suryanarayan, S. (2009). Lateral Stability of Aircraft Nose-Wheel Landing Gear with Closed-Loop Shimmy Damper. Journal of Aircraft, 46(2), 505-509.
[46] Kushida, Y., Hara, S., Otsuki, M., Yamada, Y., Hashimoto, T., & Kubota, T. (2013). Robust landing gear system based on a hybrid momentum exchange impact damper. Journal of Guidance, Control, and Dynamics, 36(3), 776-789.
[47] Denery, T., Ghidella, J. R., Mosterman, P. J., & Shenoy, R. (2006). Creating Flight Simulator Landing Gear Models Using Multidomain Modeling Tools. InAIAA Modeling and Simulation Technologies Conference and Exhibit (p. 6821).