REVIEW PAPER ON OLEO-PNEUMATIC SHOCK ABSORBER AND LATEST ADVANCEMENTS

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Abstract

Oleo pneumatic safeguards are utilized in practically a wide range of airplane to disperse the motor vitality of airplane without moving the heap to airplane structure. Vibration examination of an airplane arrival gear framework having oleo-pneumatic stun swagger incorporated pilot singe and pilot body are joined to give a stage to assess investigation of vertical vibration brought about by runway excitations. A framework is likewise utilized in airplane for observing, estimating, processing and showing the volume of interior fluid and gas inside an adjustable landing gear swagger. Weight sensors, temperature sensors and movement sensors are utilized to screen measure and record the effect of development and paces of landing gear swagger liquid. The versatile landing gear is fit for dynamic adaption to specific landing conditions by methods for controlled water-powered power and target of the versatile control is to moderate the pinnacle power moved to the airplane structure during touchdown and therefore to confine the auxiliary exhaustion factor. Expansion highlight incorporates the computerizing the investigation required to airplane landing gear before trip during the flight and during landing events.

Keywords: Landing Gear strut, Adaptive landing gear, metering pin

1. INTRODUCTION

Landing Gear Design: Dimensions of mind boggling parts, for example, openings and the material choice was finished with the assistance of this book [1]. Landing Gear Layout Design for Unmanned Aerial Vehicle in was utilized to characterize and figure the Landing load Factor [2]. A NASA specialized report incorporates the specific system for improvement of conditions of movement so as to get estimations of firmness and damping in [3]. NACA specialized report on 'Landing Gear Impact' was utilized to comprehend the advancement of scientific model to figure sway powers on the arrival gear just as for dimensioning of metering pin in [4]. Broad exploration on the conduct of oleo-pneumatic landing gears was directed in 1950s by NACA analysts with the target of creating explanatory demonstrating strategies and proper structure devices. The investigations were typically directed numerically with research center approval [5]. This is for all intents and purposes inconceivable for a standard latent LG and consequently it is improved for the most perilous, most noteworthy vitality landing situation as it were. Along these lines, in a run of the mill mill arrival the standard LG works unoptimized, albeit well beneath the most extreme plan top power, which by and by brings about superfluous high weariness [6]. It would be then conceivable to ideally decrease the pinnacle swagger power in the run of the mill low-vitality landing situations, yet in addition protect the ability to scatter uncommon, high-vitality impacts [7]. The principal results were promising yet innovative issues were accounted for since the evaluated stream paces of the pressure driven liquid were anticipated to be as high as 1000 liters for every moment [8]. These safeguards were made out of a gas spring and two water driven chambers isolated by a hole, which gave the safe response of the pressure driven liquid. This sort of safeguard was accounted for to have the most elevated effectiveness corresponding to the weight [9]. The BOEING Method an archive distributed by BOEING clarifies the models that characterizes a runway as unsuitable [10]. A specialized paper by the
National Advisory Committee for Aeronautics, in was utilized to separate information on runway unpleasantness for previously existing runways in [11]. 'The Shock Absorber Handbook' remembers the hypothesis for dampers and their development. Other information accessible included oil determination for explicit application dampers and valve plan in [12]. 'Some Theoretical Studies Concerning Oleo Pneumatic Dampers' a specialized paper discusses the issues with the current oleo pneumatic frameworks and what upgrades can be made in [13]. NASA specialized Report 'Clasping of Thin Walled Circular Cylinder' clarifies what burdens follow up on flimsy chambers and how they can be structured [14]. Ideal adjustment requires pre-touchdown acknowledgment, at any rate halfway, of the fast approaching landing situation (mass, speed, and so on.) to trigger the adjustment ahead of time and has been considered and demonstrated achievable in [15, 16]. A model is proposed and built up the idea of a whirlpool flow safeguard utilizing changeless magnets as appeared in [17]. A model is proposed and built up the electromagnetic shunt damping safeguard (EMSDA) and determined the hypothetical model and demonstrated numerically and tentatively that it could stifle the basic vibration fundamentally in [18]. A theoretical model of the twirl current damper is made and affirmed their model by tests. Their preliminary outcomes suggest that the repeat sway on the display of ECD is noteworthy at the high excitation repeat [19].

Here in this paper we discuss about different types of shock absorbers and compare them on the basis of their usefulness and mainly discussed about oleo pneumatic shock absorber and its components, advantages and latest advancements on this. We also discussed about the working mechanism of oleo pneumatic shock absorber and conceptual design of it. Some strategies also discussed for adaptive landing gear for active adaption of the strut based on sinking velocity and landing mass. We also discuss about the automating inspection on fluid level in oleo strut and use of them in better control of aircraft with new technology of electromagnetic shock absorber.

2. Shock Absorber Types

There are many types of shock absorber available in the market according to the requirements in which some are the following

2.1 Metal springs

Basically, these are used to ingest the repulsive loads and these are a negligible exertion system for reducing the effect speed and decreasing the paralyze stacking. They can work in troublesome situations over a long range of temperatures. These contraptions provide great stopping powers. These store imperativeness as opposed to dispersing it. In case metal run type shields are included, by then special treatment should be given to oblige vibrations. Each spring type has its own working qualities

These are commonly used in motorcycle and scooter rear suspension, and widely used on front and rear suspension in cars.

2.2 Hydraulic dashpot
This sort of safeguard depends on a basic water driven chamber. As the cylinder pole is moved pressure driven liquid is constrained through a hole which limits stream and subsequently avoid any accident from increase of the cylinder bar. With only one metering complete load is eased back down. The slowing down power ascends to an exceptionally high top toward the beginning of the stroke and afterward falls away quickly. On finish of the stroke the framework is steady - the vitality being dispersed in the pressure driven liquid as warmth. This sort of safeguards is furnished with springs adequate to restore the actuator to its underlying situation after the affecting burden is evacuated.

Specialized shock absorbers of this type can be used for racing purposes.

2.3 Air (Pneumatic) spring

These contraptions use air as the adaptable medium. Air contains essentialness amassing limit diverged from metal or elastomer materials. For commitments with greater loads and redirections it is regularly undeniably continuously littler that the relative metal or elastomer device. As a result of the compressibility of air these possess a firmly increasing force trademark. A large portion of the imperative is devoured around the farthest furthest reaches of the stroke [20].

Air spring used on machines, automobiles, and bushes.

Oleo pneumatic shock absorber is a combination of hydraulic dashpot and air spring in which both act simultaneously to provide a safer and more comfortable landing of aircrafts or shock absorption wherever these are used.

3. Oleo Pneumatic Shock Absorber

The essential goal of an oleo-pneumatic swagger is to hose the power of effect during landing. The optional target of this framework is to smoothen out the knocks during navigating.

3.1 Components

The oleo pneumatic safeguard involves a few key parts that progressively communicate to ingest the setting down vitality of airplane. Common Oleo pneumatic safeguards contain:

- An external chamber
- An internal chamber
- A cylinder
- Piston pole
- Piston head
- Working Fluids
- Gas (nitrogen)
- Liquid (Hydraulic)
The external chamber encases the entire safeguard and stays static as for the airframe during activity. This chamber must have the option to withstand the inner weight made by the working liquid and gas during activity. The internal chamber is allowed to move a pivotal way as for the external chamber. The inward chamber should likewise have the option to withstand critical inside weight, because of both static and dynamic stacking. The cylinder and cylinder bar are arranged inside the external chamber and stay fixed. The cylinder head has a progression of gaps in it, which act like a whole plate, and is basic in retaining the vitality of the arrival. The inward chamber is filled altogether with the pressure driven liquid, generally some sort of oil, and the external chamber contains a mix of working liquid and working gas, which is most usually unadulterated nitrogen. Minor departure from this arrangement exist anyway they all contain a chamber, an opening plate, pressure driven liquid and an unadulterated gas.

3.2 Conceptual Design

The improved plan of the oleo-pneumatic swagger has the accompanying highlights [21]:

- The safeguard comprises of four separate chambers—the upper chamber, the lower chamber, the snubber chamber and the lowermost air chamber.
- There are two cylinders in the framework one fundamental cylinder and a second gliding cylinder.
- The air (compacted nitrogen) section, which goes about as a spring that conveys the heaviness of the airplane during ground tasks, is contained in the lowermost chamber and is isolated from the oil segment with the assistance of a separator/drifting cylinder. This is done to forestall emulsification of oil on blending in with air.
- The primary cylinder isolates the upper chamber from the lower oil chamber and the snubber chamber. It contains the primary hole and two snubber openings.
- The primary opening, alongside the metering pin, controls the damping attributes of the framework.
- The metering pin is unbendingly fixed to the highest point of the external chamber. As the swagger strokes, the changing size of the metering pin goes through the consistent opening in the hole plate, causing a variable compelling hole measurement, for example variable liquid damping.
- The snubber opening leads into a little volume on the posterior of the cylinder head, known as the snubber chamber. The reason for the snubber is to give damping when the swagger expands.
- The snubber holes are variable as in they have a huge opening in the pressure stage and a littler hole in the augmentation stage. This expands the damping coefficient during expansion, along these lines giving a higher backlash damping, which is important to keep the airplane from skipping off the ground on landing.

3.3 Latest Advancement on Oleo Pneumatic Shock Absorber

Vibration Analysis
To give security and dependability to the airplane and the travellers vibration investigation of the airplane is fundamental. An all around planned LG must have the option to continue the arrival effect and waviness of the runway. Overabundances of vibration influence the capacity of the pilot and increment the odds of mishap [22].

To empower the vibration investigation coordinated with biodynamic pilot model, oleo pneumatic safeguard rewarded as customary mass-spring-damper framework having nonlinear damping and firmness properties. In this model, airplane elements incorporate vertical movements of fuselage and tires. An improved two-level of-opportunity mass-spring-damper model is appeared in Figure 1. The pressurized nitrogen gas creates the spring power and vitality dispersed by the erosion through the hole is the damping power.

![Figure 1. Quarter vehicle model of landing gear [22]](image)

The waviness of the runway instigated power which is transmitted through tires. The gas spring power, damping power and grating power are displayed as polynomials of safeguard stroke and speed. The information from is taken as exploratory information and utilized bended fitting to create non straight firmness and damping model. In spite of the fact that quarter vehicle landing gear model thought about gives a significant stage to run numerical reproductions, biodynamic pilot model has not been mulled over yet. To manage impact of the runway lopsidedness on the pilot during navigating increasingly nitty gritty numerical model must be built.

**Adaptive Landing Gear**

In actuality, issues there are a few setting down states of the airplane like the mass of the airplane or the variable sinking speed and the drag of the air.

The mass per swagger and sinking speed are two fundamental boundary of the airplane which influence the arrival situation the most.
To defeat these challenges because of variable states of mass and sinking speed a versatile landing gear is utilized which is equipped for dynamic adaption to specific landing conditions by methods for controlled water driven power.

Our fundamental goal is to limit the pinnacle power moved to airplane structure during touchdown and along these lines to restrict the auxiliary weariness factor and this is conceivable by utilizing versatile landing gear.

There are essentially two sorts of landing conditions:
1. Low vitality landing (low sinking speed and low mass)
2. High vitality landing (high sinking speed and high mass)

Low vitality landing is regularly landing condition. To plan a LG that can scatter ideally both low vitality and high vitality arrivals yet for a standard uninvolved LG it is essentially unimaginable and subsequently it is streamlined for the most hazardous, high vitality landing situation as it were.

Because of high pinnacle power the weakness associated with the structure and lessens the administration life of airplane. The auxiliary weakness factor could be incredibly decreased if a LG is fit for adaption to every specific arrival situation [23].

Our principal objective is to limit the pinnacle swagger power happening during the arrival. The arrival situation is thought to be characterized by two boundaries
1. Mass per swagger
2. Velocity

**Passive Landing Gear (PLG)**- The whole zone Ao is steady and can't be acclimated to specific landing conditions. In any case, it’s pre-set consistent worth is upgraded to alleviate the pinnacle swagger power happening at the most noteworthy vitality landing conditions (greatest plan landing mass and sinking speed).

**Semi-dynamic Landing Gear (SLG)**- The opening region Ao is ideally set legitimately before each arrival, in view of the genuine sinking speed v0 as well as mass m, which must be estimated or known ahead of time. Ao stays steady during the arrival procedure, which makes the methodology moderately simple to actualize, since no brisk shut control circles are fundamental.

**Active Landing Gear (ALG)**- The opening region Ao changes persistently during the arrival procedure, as per a system characterized by the real estimations of the underlying sinking speed v0 or potentially mass m, which must be estimated or known ahead of time. This system conceivably yields the most noteworthy improvement, yet requires fast shut control circles and exact constant estimation information, which may bring about hazards.

### 3.4 Application

Primary application of oleo pneumatic shock absorbers is in aircrafts landing gear but now the field of application has grown rapidly and some of the latest applications of it are as following:

- Hydro pneumatic suspension framework is a kind of engine vehicle suspension framework which is utilized in Rolls Royce, Maserati and all the more as of late have been utilized in Mercedes Benz in light of the fact that it gives a lot of smoother and more secure
stun retention contrast with other safeguard and furthermore it is anything but difficult to control with the assistance of sensors.

- Similar frameworks are additionally generally utilized on present day tanks and other enormous military vehicles.
- The Quadro scopes of engine bike utilize the oleo swagger to take into consideration low speed lean [24].

### 3.5 Advantages

- The essential bit of leeway of this safeguard is the capacity of the safeguard to react and keep up an even burden condition on the airplane without moving high transient burdens to the airplane structure under serious unique conditions which would have caused earlier safeguards to come up short or base and move the heap to the aircraft [25].
- Oleo swagger pad landing effects or knock annoyance and hoses rehash motions just as propensity to bounce back or 'bob' [26].
- This safeguard is equipped for dealing with the kinds of transient loads and stuns experienced by an airplane arrival gear safeguard over the span of arriving on ill-equipped landing destinations. Ill-equipped landing destinations are those which have obstructions, as, tree stumps and potholes. Such a safeguard must be prepared to do successfully diminishing transient unique burdens which result from high speed of drop along with effect or stun loads.
- This safeguard has the upside of having insignificant weight and of being able to do extremely quick powerful reaction to serious transient burden conditions.
- A versatile landing gear is fit for dynamic adjustment to specific landing conditions by methods for controlled water driven power and alleviate the pinnacle power moved to the airplane structure during contact down, and in this way to confine the auxiliary weakness factor.

### 4. Future innovation

#### 4.1 Automated Inspection of Aircraft Landing Gear Internal Fluid Level

Appropriate liquid overhauling level is characterized by the correct volume of both nitrogen and water powered oil in the swagger and it is characterized and affirmed via airplane maker.

The goal of late explorations on the LG’s is to give an implies that can screen the liquid level in the LG all the more viably and lessen the structure multifaceted nature and programmed observing giving a device to record8 and giving an instrument that consequently quantifies the interior weight of the swagger during the flight. Increment in the inside compel identified with slipped by time as for the inward volume showed the over-the-top measure of nitrogen gas. Information on landing gear swagger weight during the arrival is likewise a target for the estimation of nitrogen and pressure driven oil volume. There are proficient techniques for pressure estimation while the airplane is in flight.
A temperature remunerated weight of the liquid in the swagger is resolved and contrast this weight and the weight comparing to legitimate assistance conditions. The assurance of weight is accomplished for each progression of the airplane like when the take-off starting from the earliest stage. The weight is contrasted and a limit esteems and in the event that the weight surpasses the edge esteem, at that point a sign of low non compressible liquid is given. So, by the information on interior liquid weight, we can quantify inside liquid level.

The current innovation can play out a robotized investigation of measure of both water driven oil and nitrogen gas contained inside the LG stun swagger by observing airplane LG swagger pre charge weight and looking at each resulting post take off pre charge strain to that of an appropriately adjusted landing gear swagger [27].

4.2 **Electromagnetic Shock Absorber**

Assessment of the effects of a twirl current damper on a cantilever column and their exploratory results showed that this whirlpool current damper can be a suitable contraption for vibration disguise in [28]. A theoretical model of the twirl current damper assembled and further made and utilizing this speculative model, they inspected the damping characteristics of the vortex current damper and re-authorized the vibration covering of a cantilever shaft with the associated whirlpool current damper [29].

Figure 2 describe the three-advance shock charming instrument of the proposed electromagnetic defend (EMSA). Four sorts of forces used in these three paralyze holding structures. The chamber and magnet is from the outset arranged at the most elevated purpose of a copper tube in light of an interest power. The underlying advance is where a shock is applied to the EMSA, the chamber and the magnet starts to move plummeting yet is against moving by the engaging appealing force between the magnet and the steel ring at the chamber end. This alluring force is on the other hand comparative with the partition between the magnet and the steel end. The resulting advance is: where the magnet is moving there exist two sorts of forces. One is the twirl current damping power between the moving magnet and the fixed copper tube. The other is a pounding power between the magnet and the chamber. It uses the disintegration capacity to assemble the outright dispersal power despite the ECD power. The disintegration power is normally relating to a customary force between two surfaces. In it the common force is the appealing alluring force between the magnet and the outer steel tube [30].
5. Conclusion

The following conclusion are made based on the review study

- The adaptive strategies are effective over passive certified by both numerical simulation and laboratory test.
- Active strategy is beneficial over semi active strategy only on high energy conditions and it significantly mitigates peak strut force.
- Partial knowledge of landing conditions is essential for taking advantages.
- The proper level of fluid volume in strut is essential for proper working of strut. And volume can be determined by internal pressure change rate.
- Simulation studies reveal that oleo pneumatic landing gear has a lower capability of vibration mitigation.
- In the main interest of frequency range designing an active control system improves the performance in the low frequency range might be a direction of future work.

References


