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Landing gear hubcap modification

The hubcap modification for tire wear reducing upon touchdown is considered. This modification provides improvement to landing gear wheel hubcap design that allows spool up of the main landing gear during landing stage.

Tires are the crucial part of the landing gear of modern age commercial aircraft. They are designed to withstand high loads and strong friction during landing. Aircraft tire tread patterns are designed to facilitate stability in high crosswind conditions, to displace water away to prevent hydroplaning, which degrade braking effect. Because of such loads, time in service of the tires of the landing gear are significantly shortened and airlines have to keep a revolving fund of landing gears for quick replacement in case of tire burst or damage. Maintaining such infrastructure creates significant additional expenses for an operator.

There are several factors affecting tire performance to consider. Internal tensile force acting on each tire fabric layer are uniformly distributed while in the unloaded condition. When loaded, tensile force on the outer part of the tire will be higher than on the inner part. As a result, shear force is developed between layers of fabric. Common types of damage associated with these forces are shoulder separation and lower sidewall compression break (Fig.1).

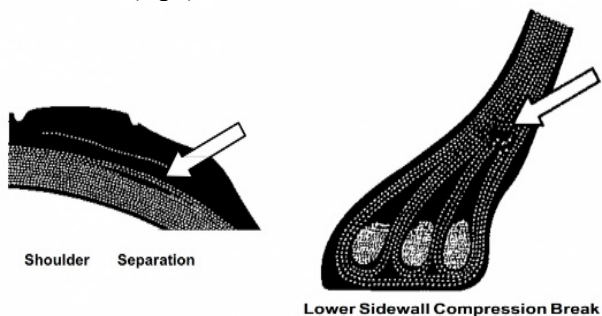


Figure 1: Common types of tire damages

Heavy load and high speed cause a major heat generation. The resulting high temperature adversely affects physical properties of rubber compound. As a result, when rubber reverts to the incurred state, both strength and adhesion are lost.

Because of centrifugal force and inertia during touchdown, the tire surface overshoots, briefly distorting from its natural shape, causing a traction wave in the tread surface. Traction wave is mostly affected by two factors - speed and underinflation.

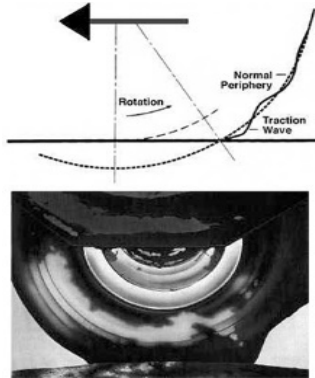


Figure 2: Traction wave in the tread surface

All forces listed above are negatively affect tires service life and mainly caused by the impact with the runway during the touchdown. Reducing impact of those forces on the landing gear tires could drastically increase lifespan of those components. By pre-rotating the wheel of the landing gear, one could achieve a significant decrease on those degrading forces.

Hubcap modification

Conventional landing gear hubcap are usually made of uniform material to cover the bolt connection of the gear to the trolley for better aerodynamic during take-off and landing while gears are in extend position. While such design improves an aerodynamic characteristics of landing gears, it also misses the opportunity for pre-rotating wheels before landing to minimize impact wear on tires, especially during the touchdown.

By shaping the hubcap as a fan, leveraging of the airstream flowing around the landing gear in flight could be achieved. The spool up device captures the airstream to produce torque that initiates rotation of wheels. This torque continues to accelerate the wheel until them matches the airstream speed. In ideal case, wheel rotation speed would be equivalent to the aircraft's landing speed. In practice, device could achieve a fraction of landing speed, leading to significant reduction in tire wear as wheels will be already spinning during the touchdown, reducing traction waves.

Due to various landing gear types are used in aviation, multiple configurations of a spool up device could be necessary. For general aviation, hubcaps with simpler design could be manufactured by metal stamping or forming. For larger commercial aircraft, more advanced production techniques could be used such as machining or forming of composite materials. Regardless of the specific variants, hubcap manufacturing cost will be still more commercially compelling than maintenance costs of unserviceable tires.

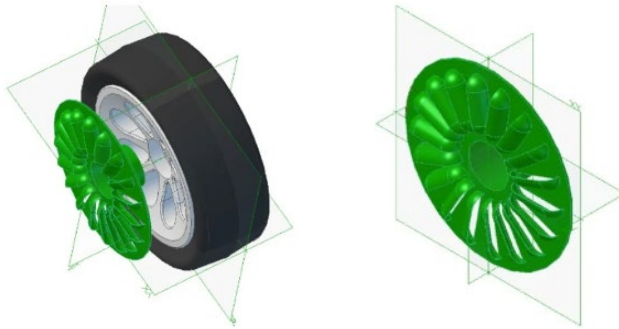


Figure 3: Modified landing gear hubcap

Conclusion

The proposed modification to the landing gear hubcap could lead to a significant reduction in tire wear during aircraft landings. By redesigning the hubcap to function as a fan, the airstream during flight can be harnessed to pre-rotate the landing gear wheels before touchdown. This mitigates the harmful forces exerted on tires upon landing, thereby extending their service life and reducing the frequency of costly replacements and excessive maintenance, increasing operator's profitability.

References

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2. Aircraft Wheel Hub Cap [Website] // The Create the Future Design Contest, - 2011. <https://contest.techbriefs.com/2011/entries/transportation/1834>