SAE A-5 Aerospace Landing Gear Systems Committee Meeting

Presentation: October 8, 2008: Time 14:45～15:25

A Revolutionary Concept for Nose Landing Gear

1. Two Independent Shocks: F_Y, F_X

When an aircraft wheel strikes an obstacle on the runway at high speed, it receives two independent shocks - F_Y and F_X – as shown in Fig.1. F_Y is the vertical impact generated as the wheel is forced to move upward. F_X is the longitudinal impact generated as the wheel meets great resistance to forward motion.

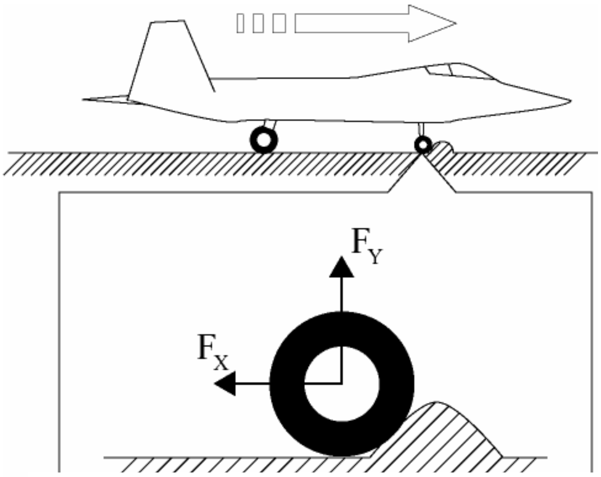

Fig.1 Two independent shocks F_Y, F_X

2. Discovery of Technological Limit

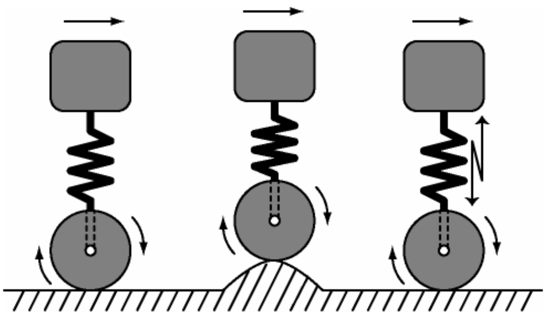

Fig.2 Established suspension model for vertical input.

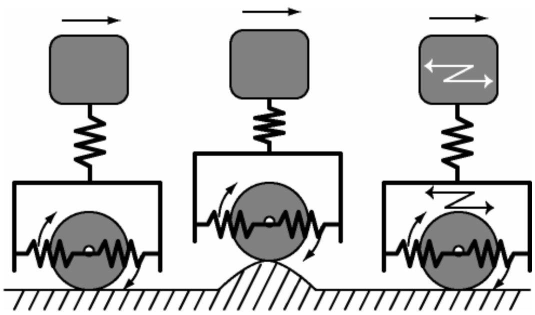

Fig.3 Suspension model for vertical and longitudinal inputs.

Fig.2 shows the established suspension model, supporting by spring and wheel. This model maintains smooth longitudinal progress.

Fig.3 shows a suspension model added for longitudinal impact, supported by spring. In this case, increase and decrease of spring force in the forward direction generate acceleration and deceleration of the vehicle body, thereby hindering smooth progress. This is why longitudinal suspension does not exist. Technological limit is here.

3. A Change from Pendulum to Suspension System

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3.1 First step of change

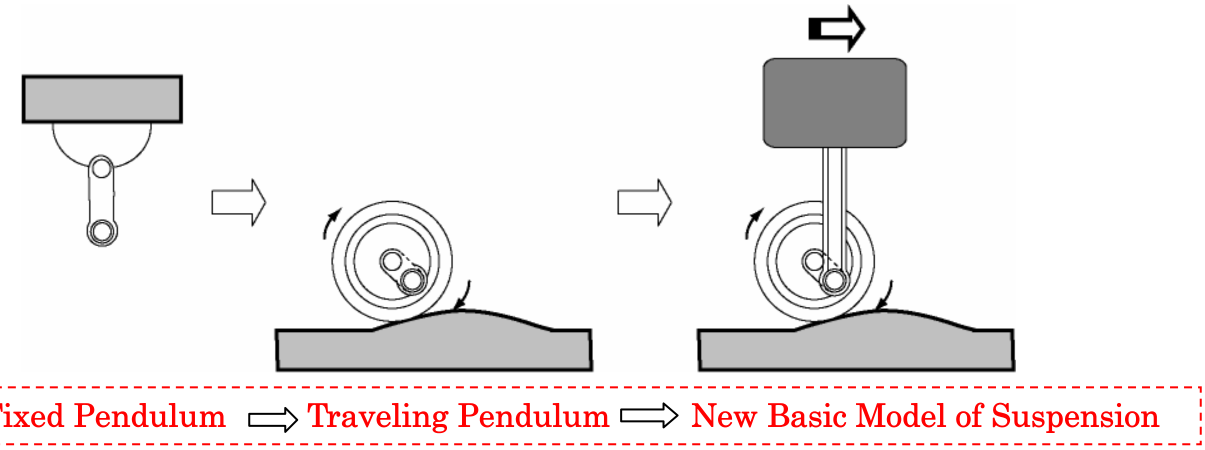


Fig.4 Creation of a new basic model of suspension

I have created a new concept shown in Fig.4 that pendulum travels in the middle figure, supporting by wheel axle. When the wheel is driven, the pendulum travels across the United States!? When the wheel strikes an obstacle, pendulum swings due to its own inertia.

3.2 Second step of change

Weight of vehicle body is applied to the lower center of the pendulum and the joint part is allowed to rotate. I have named the new pendulum shape “crank element”. I have created a new basic model of suspension.

4. Overcoming the technological limit

4.1 Stroke of wheel in crank element

The left side of Fig.5 shows the vehicle moving on a flat surface. The crank element is standing vertically. When the wheel encounters a bump, the crank element swings. The stroke of the wheel axle, when compared with the crank element fixed, is expressed in the figure. The back stroke is ΔL; down stroke is ΔH.

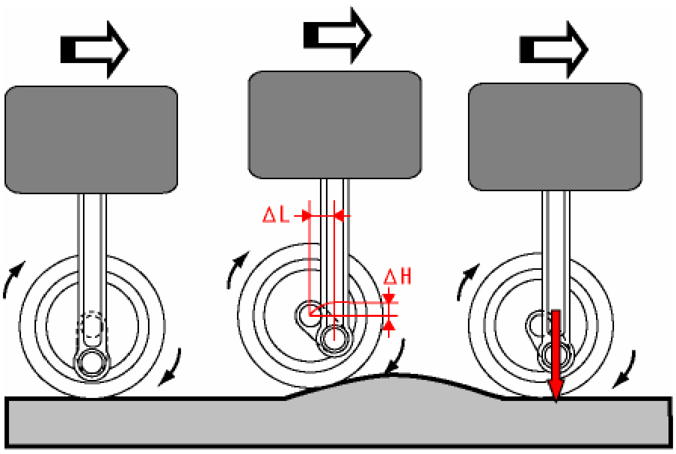


Fig.5 Return force of gravity spring

4.2 Overcoming the technological limit

After responding to the forward impact, return force drawn by red arrow in Fig.5 is the weight of the vehicle body without acceleration or deceleration to forward motion. Gravity is perpendicular to traveling direction. A gravity spring does not hinder smooth progress like elastic springs. This is the solution to overcome the technological limit.

5. Crank Buffer Strut

I conducted the first application of the two basic models shown in Fig.2 and Fig.5, and created a new suspension system model for large aircraft. I have applied this model to aircraft nose landing gear shown in Fig.6. This nose landing gear is composed of oleo buffer strut and a crank element. The new buffer strut is named the Crank Buffer Strut (USA Patent No.7,051,977). It was featured in *Aerospace Engineering,* July 2002 pp27～29. The new system has vertical and longitudinal springs, and their vibration is suppressed by an oil damper for the oleo strut and by a disk brake damper for the crank element.

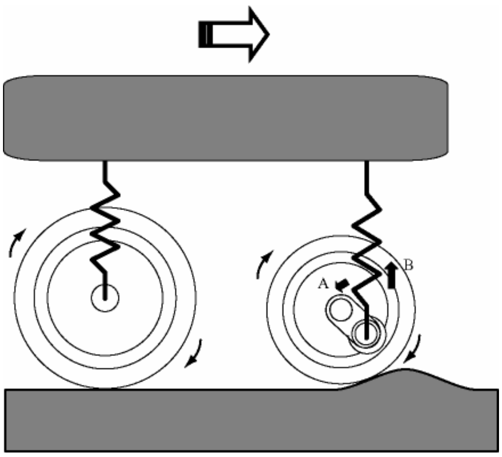
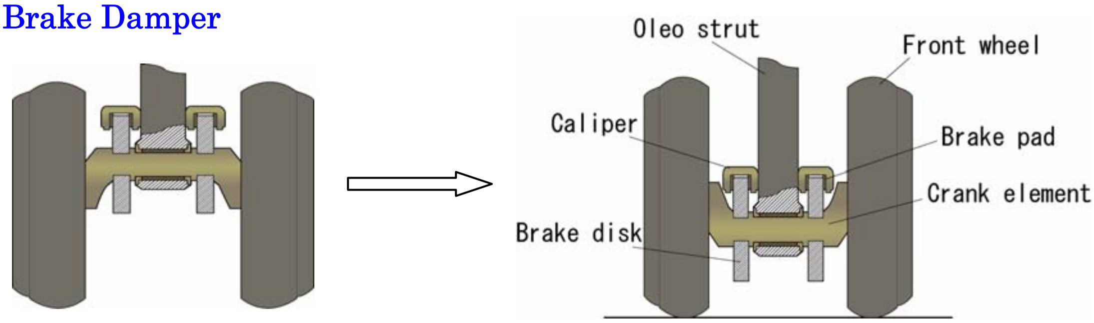


Fig.6 The new suspension system model for large aircraft

6. Disk Brake Damper



(a) Before contact with runway (b) After contact with runway

Fig.7 The new nose landing gear concept with disk brake damper

Figure 7 (a) illustrates the new nose landing gear concept with a disk brake damper before contact with runway. To enable circle displacement, the nose wheel is supported by a crank element at the bottom end of the oleo strut. Two brake disks are installed on the crank element and brake pads inside caliper are pressed on the disks. Right side (b) shows after contact with runway. On landing, the crank element turns a half circle from figure(a) to (b). The motion is controlled at high speed by the disk brake damper system.

7. Properties of Steering

Figure 8 shows a plane figure to look down the motion of the crank element. When the nose wheel moves in response to forward input from the runway, the crank element shifts position as indicated by the center red arrow. The nose wheel maintains direction of motion, and therefore the crank

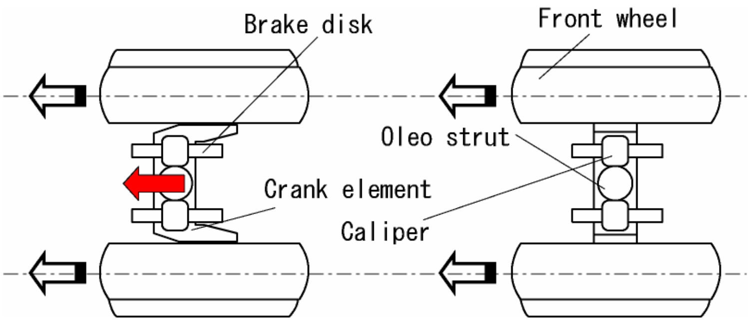


Fig.8 Look down on the motion of the crank element

element does not impair steering stability.

8. Benefits

I believe that application of my suspension model to nose landing gear provides the following benefits.

(1) Reduction of spin-up and spring-back on landing

(2) Optimum control of decent impact including in an emergency

(3) Prevention of tire rupture on striking an obstacle on the runway.

(4) Bomb - damaged runway capability is increased for combat aircraft.

SAE Technical Papers

(1) K. Yoshioka and A. Sone
"Aircraft Undercarriage Concept"
Aerospace Engineering, July 2002, pp 27-29

(2) K. Yoshioka, A. Sone, A. Masuda and S. Kondo
"Research on a New Aircraft Undercarriage to Prevent Tire Smoking on Landing"
Aerospace Congress & Exhibition, 2003-01-3048

(3) K. Yoshioka, A. Sone, A. Masuda and H. Yamashita
"Smoothing Runway Travel to Improve Safety and Lower Maintenance Costs"
SAE 2005 Transactions Journal of Aerospace, pp 1412-1426

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