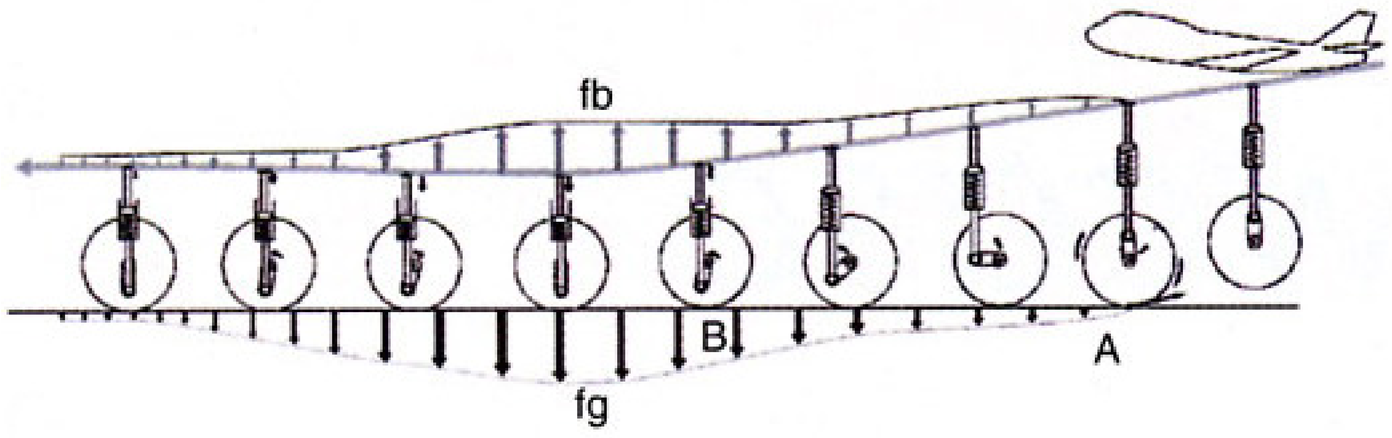

Figure 5. Action of the undercarriage on landing.

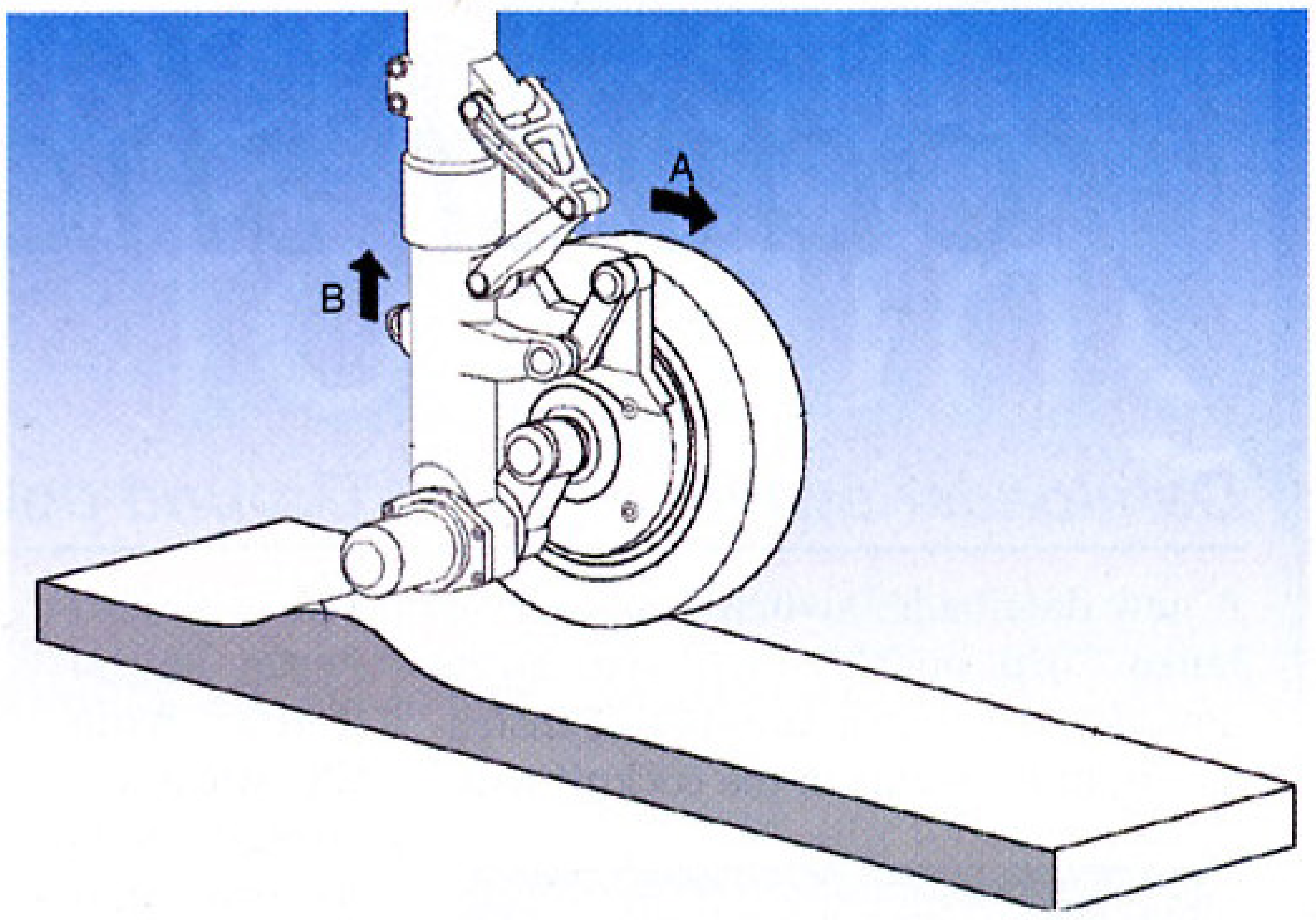

Figure 7. An angle view of the new undercarriage as it travels over an obstacle.

wheel encounters an obstacle while rolling along the runway, it displaces in direction A to lessen the impact force (Figure 7).

Another consideration regarding the new suspension system was whether the crankshaft generates unwelcome vibration while the aircraft is rolling along the runway at high speed. The crankshaft swings as a pendulum from the lower equilibrium point. At that instance, the wheel experiences longitudinal parallel displacement, but not angular displacement about the perpendicular line, which leads to the expectation that no loss of stability will occur in high-speed rectilinear motion. If the amplitude of circular vibration increases leading to unpleasant resonance, the torque generator can attenuate vibration amplitude.

Test procedure

To demonstrate their concept, researchers applied the suspension principle to the front wheel of a motorcycle. The shock-isolating effect and suspension characteristics were investigated systematically.

The impact test was performed using a pulling-type apparatus. The motorcycle was run into a concrete barrier at various speeds. Engineers studied the exponential relationship between the maximum output from the load cell (representing maximum tire load) and the impact velocity (Figure 8). The value for the modified motorcycle was always about 30% smaller than the value for the conventional motorcycle. From this data, engineers concluded that the new crankshaft suspension had a positive shock-isolation effect.

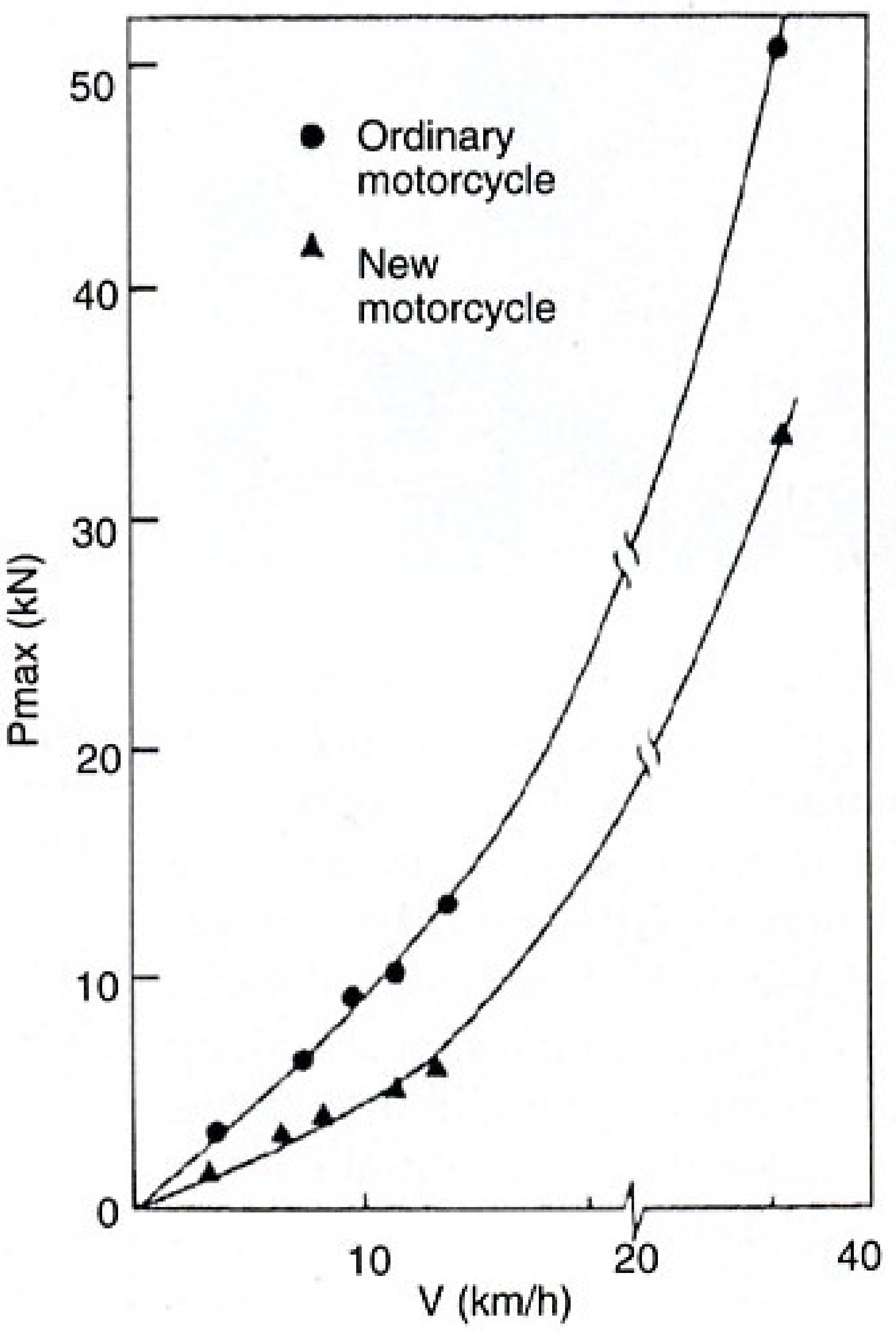

Figure 8. Relationship between maximum tire load and impact velocity.

To determine the system's vibration characteristics and running stability, engineers performed a series of riding tests. Vibration and handling evaluations were initially conducted on test courses, followed by highway riding tests. Two motorcycles, one with the isolator and one without, were tested and compared in each case.

Preparation for the vibration test included paving the path with concrete for a relatively rough surface and arranging triangular obstacles on the course. Researchers measured sprung mass acceleration on the handlebars and bending stress at the fork root. Since bending stress directly measures longitudinal shock on the vehicle, and lower stiffness in the longitudinal direction is considered to reduce shock applied to the vehicle and improve suspension system characteristics, bending stress was measured to determine the effects of the isolator on suspension characteristics.

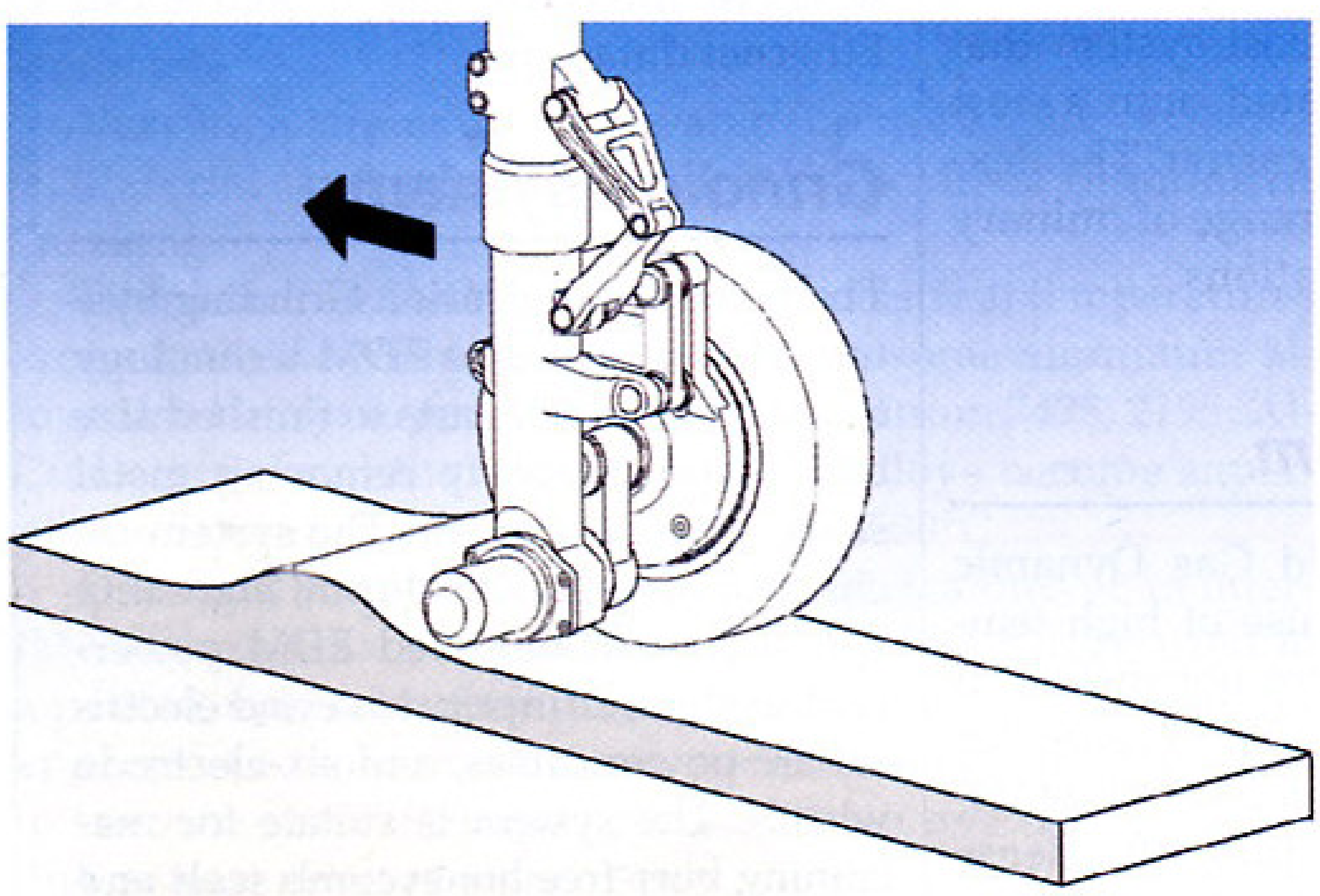

Figure 6. An angle view of the new undercarriage when traveling on the runway.

Test results indicated a reduction in root mean square value of the sprung mass acceleration by about 18% and a reduction of bending stress by about 30%.

A stability test was performed to determine handling performance. For the stability test, a rectangular obstacle with a height of 65 mm and a width of 110 mm was placed on the test course at an angle of 45° to the straight line. A test rider rode two motorcycles, with and without the isolator. When the motorcycles struck the obliquely placed obstacle, the handlebars became unstable and the motorcycles diverged from the straight course. The distance between the divergent path and the straight course was smaller and handling was more stable in the motorcycle with the isolator.

Based on the motorcycle experiments, researchers believe that application of a suspension based on the new principle to aircraft undercarriages will provide considerable benefits by solving the safety problems of excessive tire wear and rupture.

Information for this article was provided by **Koji Yoshioka** of SUS21 Co. Inc. and **Akira Sone** of the Kyoto Institute of Technology.