CRITICALLY STUDY OF BRAKING OF AN-32 AIRCRAFT AND ENHANCEMENT OF ITS ANTI SKID SYSTEM

Minor project report submitted in partial fulfillment of the degree of

MASTER OF ENGINEERING
IN
PRODUCTION ENGINEERING

BY
RAJIB LOCHAN PANIGRAHY
(Roll no: - 12/PE/01)

Under the supervision of

Sh. R.C. Singh

MECHINICAL ENGINEERING DEPARTMENT

DELHI COLLEGE OF ENGINEERING, DELHI.
JULY 2005

CRITICALLY STUDY OF BRAKING SYSTEM OF AN-32AIRCRAFT AND ENHANCEMENT ON ITS ANTISKID SYSTEM.

INTODUCTION

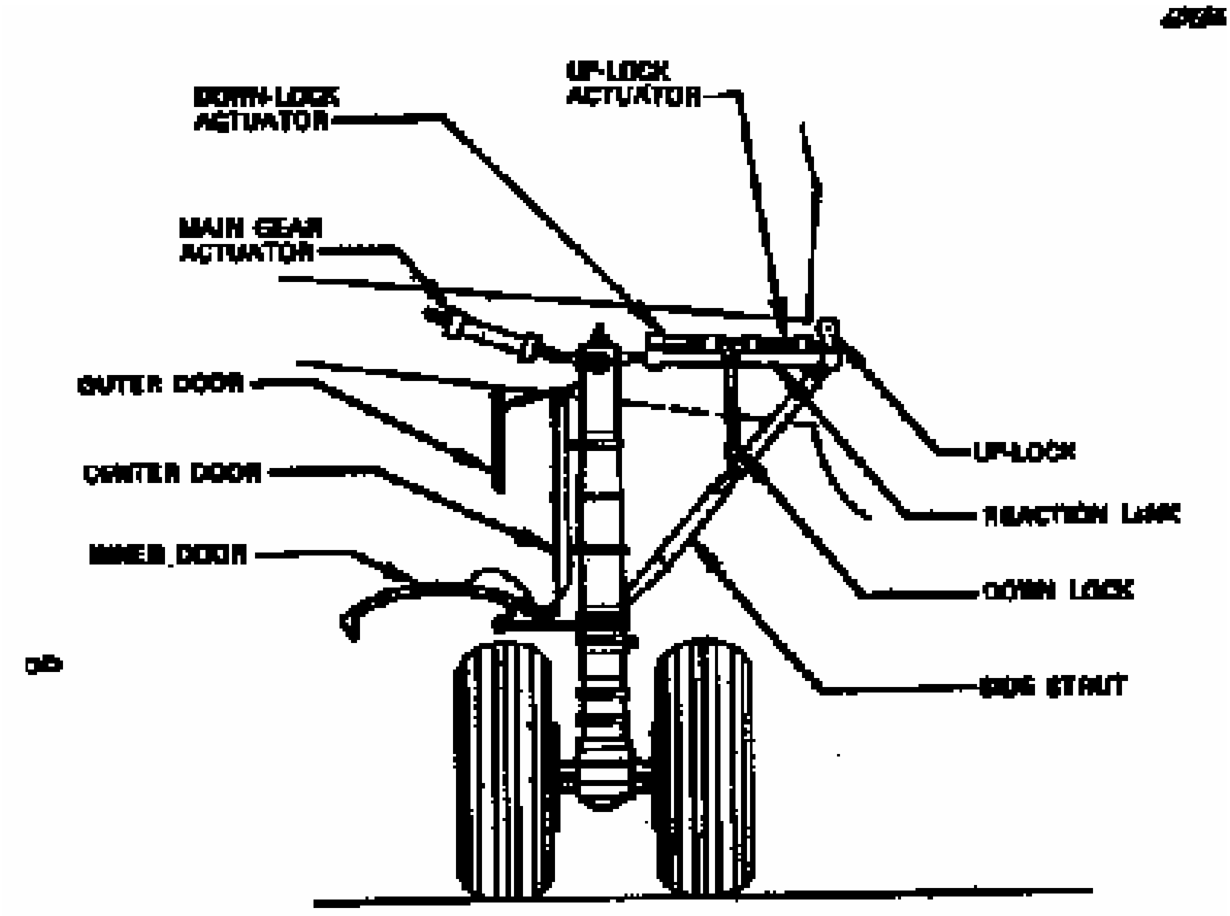
This is a Russian built aircraft. It has short take off and landing characteristic. It is a transport aircraft intended for transportation, Para dropping and landing of troops and cargo and for airlift of sick and wounded personnel. It is a high lift cantilever monoplane, all metal constructions with tri-cycle landing gear. The aircraft is fully pressurized and air-conditioned. The passenger compartment with a controllable air temperature enables the aircraft to be used in airlift of perishable goods. The aircraft can take off and land from high altitude airfields up to 4500 meters under all climatic conditions in day and night.

LANDING GEAR

The landing gear of an aircraft constitutes a vital element in aviation design as they take up the entire static and dynamic load of the aircraft. All the components of the landing gear are subjected to severe impact loads during landing and take off and shack loads during taxiing. Consequently their design, within constrains of size and weight such that they impose minimum structural penalties, become a challenging task for the designers.

The design of landing gear is often a compromise with wheel and brakes having the size and strength commensurate in supporting the aircraft on ground and while landing and taking off. Almost all the present generation aircraft incorporate a retractable type landing gear so as to retain the streamlined profile of the aircraft without imposing drag penalty.

The landing gears of this aircraft are of tricycle type with retractable undercarriage comprising of two main landing gears and a steer able nose



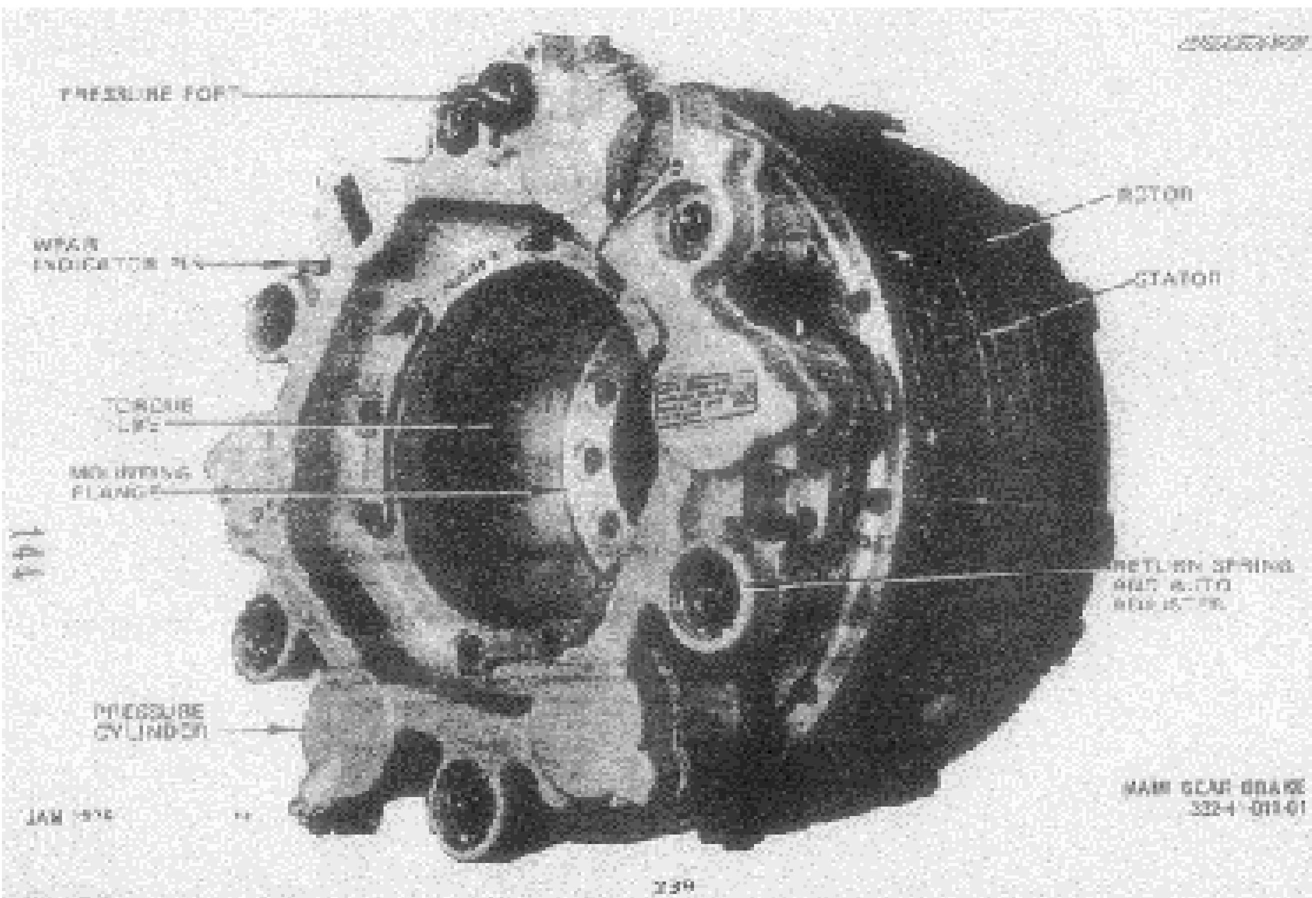
Main Landing Gear

landing gear. The main landing gears provide aft support for the fuselage. The main and nose landing gear use air-oil type shock strut to observe impact on landing and vibration and shock from movement of the airplane on the ground. Each main landing gear and nose landing gear is equipped with two tyres and wheel assembly. Each main landing gear is fitted with disc type hydraulic brakes modulated by an antiskid system. Each main landing gear also transmits the braking force to the airplane structure.

The main landing gear is hydraulically actuated to retract inboard into the fuselage. Each main landing gear is locked tin the down position by folding lock strut and in the up position by an up-lock hook and mechanism. Shock strut doors close the opening in the wing for the main gear, when the air engine flight with gear retracted. Manual extension is available incase of a hydraulic system malfunctions.

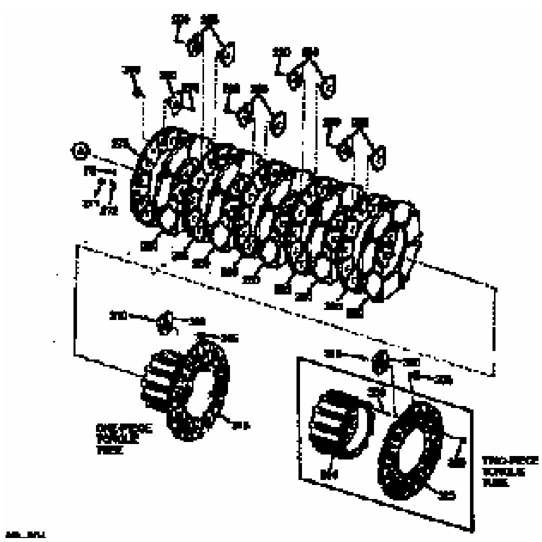
<u>MAINWHEEL BRAKING WITH ANTISKID SYSTEM</u>

The purpose of friction brakes is to decelerate an aircraft by transforming the kinetic energy of the aircraft to heat via friction and dissipating that heat to the surrounding. The brake pad requires many properties such as high strength; constant friction coefficient, low wear rate, low noise and anti shudder characteristics

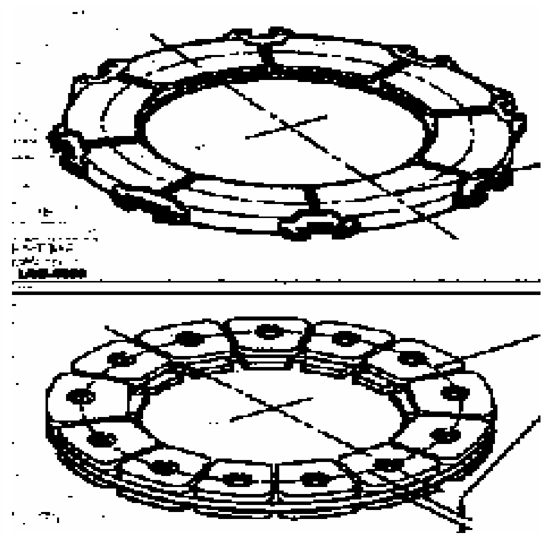


Main Gear Brake

The aircraft wheels braking system provides means to control the airplane speed during parking and ground maneuvering. Stop wheel rotation after takeoff and shorten the landing run. A disk type brake is mounted on each of the four main gear wheels. The brakes are manually controlled by the captains or co-pilots rudder brake pedals. The intensity of braking depends upon the force exerted on the pedals. Parking brakes are intended to hold the aircraft in parked condition by locking pedals in partially depressed position. The emergency braking is resorted to in the event of failure of main brakes and is effected by operating the emergency braking levers.



Main Gear Assy Exploded View



Brake Unit Rotor and Friction plate.

(A) NORMAL BRAKING

Hydraulic fluid from the main system is supplied to the reducing valves of brake system. When rudder pedals are pressed, the fluid at reduced pressure is supplied to the brake cylinders of wheels through modulators, antiskid detectors and shuttle valves. The brake cylinders operate the wheel brakes. The intensity of braking depends upon the force applied on to the brake pedals, which controls the operation fluid pressure in the brake line. In this mode the emergency braking lines are cutoff. When the pedals are released the reducing valves are set to initial position, cutting off the pressure line and connecting the brakes to the return line to release the brakes.

During the operation of antiskid detector. fluid from the brakes is allowed to return through the emergency braking lines.

(B) EMERGENCY BRAKING

The emergency brakes are applied by pressing the emergency brake levers. Hydraulic fluid from the pump is directed to the brakes through the reducing valves by passing the antiskid detector unit for the emergency braking action.

(C) PARKING BRAKE

Parking brakes are applied by locking the pedals in a partially depressed position.

ANTISKID DETECTOR UNIT

The antiskid detector coupled to each wheel and brake assembly is a inertial type which prevents lock up off the wheel due to excess braking pressure during landing at high speed thus avoiding the skid. This is achieved by releasing the extra braking pressure such that the peripheral speed of the tyre is slightly less than the speed of the aircraft so that the wheel is just slipping the runway surface which causes most effective braking. The antiskid mechanism in normal braking comes to operation automatically at speed above 30 km/hr. The antiskid detector comprises an inertial mechanism to sense the angular deceleration of the wheel and accordingly controls the brake pressure into the brake cylinders. Pressure released by the antiskid mechanism is communicated to the return line via emergency line.

DISADVANTAGES

1. Due to inertial type of antiskid valve on the wheels, comparatively longer runway is required for landing.
2. Failure of any one antiskid valve may cause locking of that particular wheel, hence may cause tyre burst, which leads to an accident.
3. Pilot’s concentration is diverted for braking the aircraft hence hampering his duties to perform other controls of the aircraft.

PROPOSED ENHANCEMENT ON ANTISKID SYSTEM

An electronically controlled and hydraulically operated antiskid valve may replace the existing inertial type antiskid valve. The antiskid system prevents wheel skidding by limiting the hydraulic pressure applied to the brakes by the hydraulic system. Maximum braking efficiency is obtained when all the wheels are in a slide skid or at a maximum rate of deceleration short of a skidding wheel. The system electronically controls as antiskid control valve to continuously vary braking pressure in response to wheel rotation. The system controls wheels individually. Each wheel rate of deceleration is compared with preset rate of deceleration. Wheel deceleration within the airplane deceleration capability produces no correction signal. Wheel deceleration above this rate is treated as skid or approaching skid, and correction signal are sent to the antiskid control valve to reduce the applied brake pressure. The correction signal is reduced when the wheel return to speed again. The system continuously seeks a level of correction signal, which produce skidding of slight severity, and there by attains maximum braking efficiency.

REQUIRED COMPONENTS

The following few components are required for the proposed enhancement of the antiskid system.

1. Antiskid valve.
2. Antiskid module.
3. Transducers.

ANTISKID VALVE

The antiskid valve consists of two stages. The electrically controlled first stage valve consists of a torque motor controlling a flapper between two restricted hydraulic outlets. The torque motor moves the flapper to block one outlet while allowing free flow from the other creating a pressure differential. The pressure differential affects the second stage valve spool on either end depending on torque motor current. The second stage valve spool is spring biased in the pressure to brake position and the first stage flapper is also based to provide a pressure differential to assist the spring action when there is no current to the torque motor. The torque motor provides the pressure differential in the valve proportional to the current it has received. Any movement of the flapper tends to create a pressure differential on the end of the second stage valve spool to compress the spring and close the valve reducing brake pressure. The brake pressure responds directly to the electrical signal received from the antiskid control module.

ANTISKID CONTROL MODULE

The module contains the necessary electronic circuits for control of antiskid system. The control circuits are separated on individual cards for each pair of inboard and outboard wheels. The locked wheel detector circuits control either the inboard or outboard pair of wheels.

The control circuits contain both skid control and locked wheel-sensing components. When wheel deceleration is with in certain predetermined limits, the wheel skid control components are inactive. When the wheel speed falls below the value allowed by the predetermined maximum deceleration rate, the skid control circuits sends a release signal to the antiskid control valve for that wheel. Subsequent when spin up causes the brake to be reapplied at a lower pressure.

The reapplication pressure is determined by the length of the time required for the wheel to spin up. The skid control circuits continuously seek a level of brake application to attain maximum braking efficiency under any variety of runway condition. The locked wheel-sensing component provides a full brake release signal in the event of a locked wheel.

TRANSUCER

It is a speed-sensing device. It contains a rotor, which rotates outside a fixed stator. The stator is attached to the axel of each wheel. The rotor is attached to the hubcap and rotates with the wheel. The rotor has 72 lobes and the stator contains a permanent magnet. When the wheel is turning, which cause a change in magnetic field, which generates an AC voltage directly proportional to the rotational speed of the wheel. The AC signal is fed into the converter of antiskid module.

OPERATION

The antiskid system controls brake pressure through the antiskid valves in response to the automatic braking signal. All times to provide skid and locked wheel protection during automatic braking. The antiskid control shield contacts selected deceleration circuits which function when the automatic braking system is operating. The circuit compares actual airplane velocity, which is computed from the selected airplane deceleration rate. The difference between actual and reference velocities produce error voltage, which are processed and sent to the antiskid control valves to very brake pressure as required to decelerate the airplane at the selected rate. In the automatic braking mode, the antiskid system operates on a paired wheel basis on initiation of automatic braking, the brakes are fully released until the wheels are spin up to 65 knots airplane velocity. At this velocity automatic braking system ‘on ramp’ signal are sent to the antiskid control module which directs the antiskid valves to gradually increase brake pressure to the required level. When emergency drop out signals are received from the automatic braking control unit. The antiskid modules signals the antiskid valves to release the brake pressure instantly. When drop out signals are received, the antiskid control module signals the antiskid valves to gradually release the brake pressure to obtain smooth transfer from automatic to manual braking.

ADVANTAGES

1. Pilot can apply the brakes before landing without fear of locking the wheels, hence enabling him to concentrate on other factors for safe landing of the aircraft.
2. Maximum retardation is obtained thus shortening the landing run.
3. No skidding of wheels, so tyre life is enhanced.
4. Reliability of the system increases,

REFERENCES

1. Yuji Hand and Takahisa Kato: Effects of Cu powder, BaSO4 and cashew dust on the wear and friction characteristics of automotive brake pads.
2. Takahisha Kato and Hiroshi Soutome: Friction material design for brake pads using database.
3. Peter J Blau: Compositions, Functions and Testing of Friction Brake materials and their Additives.
4. Training manual of AN-32 aircraft
5. Component reference manual of brake unit.
6. Maintenance manual Boeing 737-200 aircraft.
7. Training manual of Boeing 737-200 aircraft.