Effect of the Gyroscopic Couple on an Aeroplane

The top and front view of an aeroplane are shown in Fig (a). Let engine or propeller rotates in the clockwise direction when seen from the rear or tail end and the aeroplane takes a turn to

the left

Let ω= Angular velocity of the engine in rad/s,

m= Mass of the engine and the propeller in kg,

k= Its radius of gyration in metres,

I= Mass moment of inertia of the engine and the propeller in kg-m 2 = m.k2

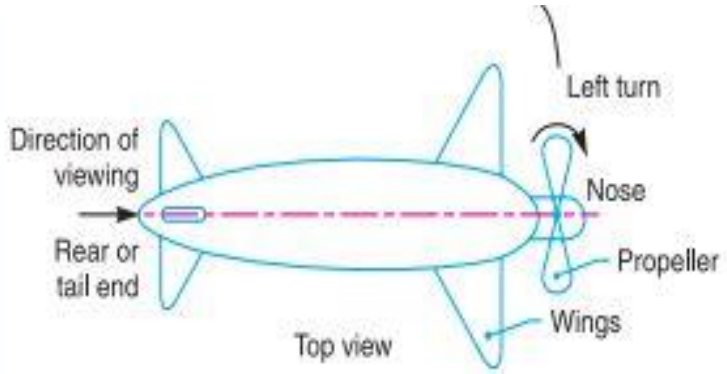
, v= Linear velocity of the aeroplane in m/s,

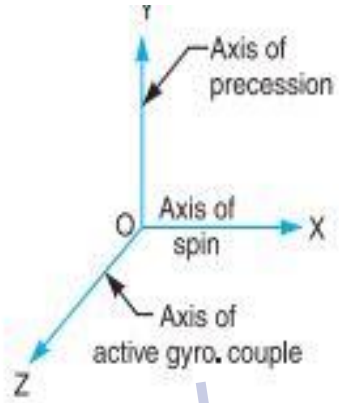
R= Radius of curvature in metres, and

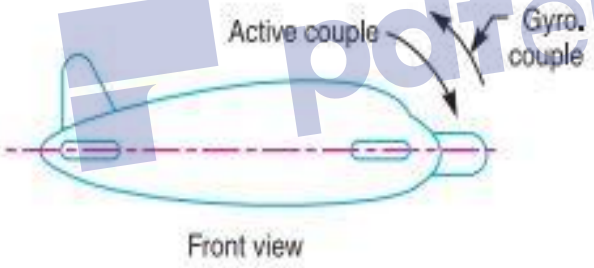
ωP= Angular velocity of precession

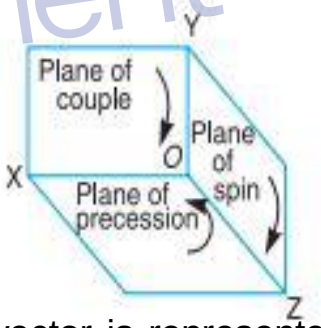
vR= rad/s

∴Gyroscopic couple acting on the aeroplane, C=I.ω.ω









Before taking the left turn, the angular momentum vector is represented by ox. When it takes
left turn, the active gyroscopic couple will change the direction of the angular momentum vector from
ox to ox′ as shown in Fig. 14.6 (a). The vector xx′, in the limit, represents the change of angular

momentum or the active gyroscopic couple and is perpendicular to ox. Thus the plane of active gyroscopic couple XOY will be perpendicular to xx′ , i.e.vertical in this case, as shown in Fig

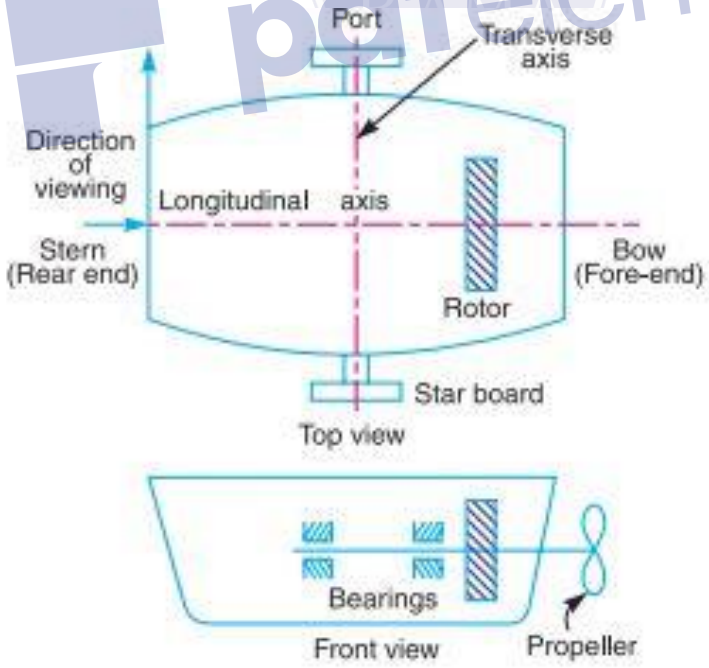
(b). By applying right hand screw rule to vector xx′, we find that the direction of active gyroscopic couple is clockwise as shown in the front view of Fig. (a). In other words, for left hand turning, the active gyroscopic couple on the aeroplane in the axis OZ will be clockwise as shown in Fig.

(b).The reactive gyroscopic couple (equal in magnitude of active gyroscopic couple) will act in the opposite direction (i.e. in the anticlockwise direction) and the effect of this couple is, therefore, to raise the noseand dip the tailof the aeroplane

Terms Used in a Naval Ship

The top and front views of a naval ship are shown in Fig. The fore end of the ship is called bow and the rear end is known as stern or aft.The left hand and right hand sides of the ship,
when viewed from the stern are called portand star-board respectively. We shall now discuss the effect of gyroscopic couple on the naval ship in the following three cases:

1. Steering,
2. Pitching, and
3. Rolling



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