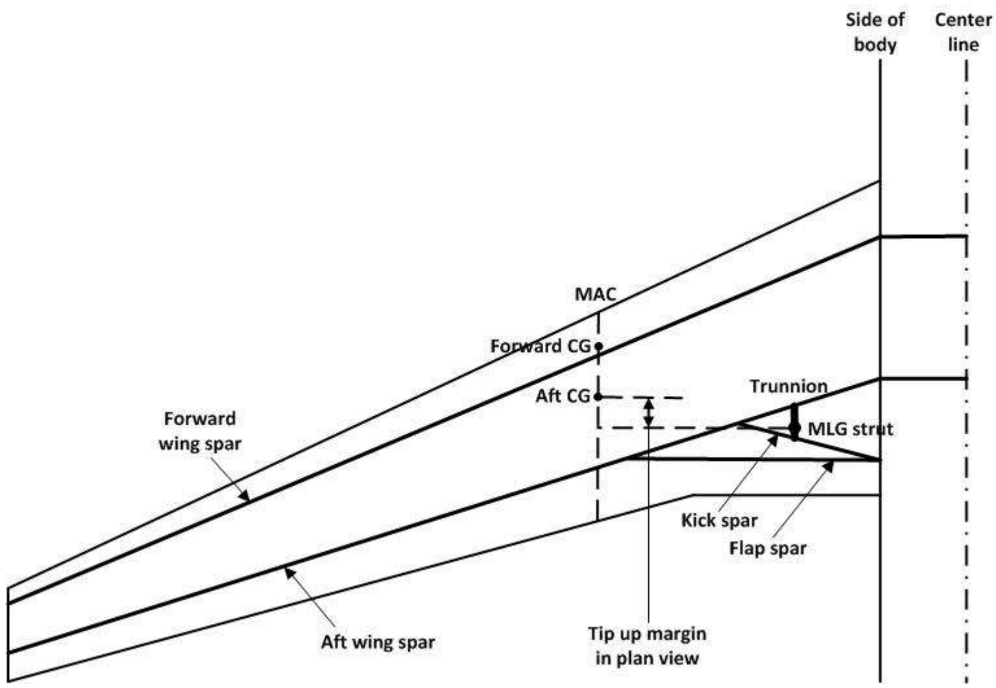
Schaufele Annotations
Chapter 7 Landing Gear Design

Longitudinal Tip Up Margin

The procedure for calculating the longitudinal tipup margin appears to be straightforward. However, it is important to take account of the location of the butt line of the m.a.c. relative to the butt line of the main landing gear.

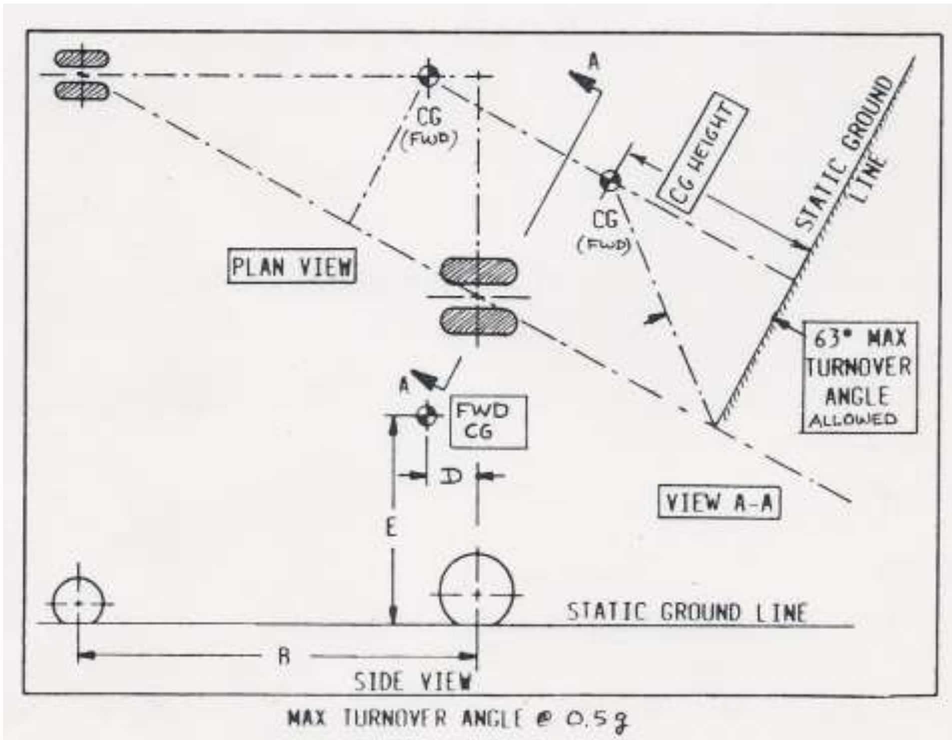


The location of the m.a.c. is determined by the geometry of the wing. At this point in the design process it may be assumed that the forward c.g. is at 15% of the m.a.c. and aft c.g. is at 35%. The center of the main landing gear (MLG) bogie must be 15^0 - 20^0 (in the side elevation view) aft of the aft location of the c.g. If the wing has moderate sweep and aspect ratio, this can normally be achieved without much difficulty. However, as sweep or aspect ratio increase, the location of the m.a.c. moves aft relative to the MLG. For a high aspect ratio wing (as on the Boeing 787), it may be necessary to cant the MLG strut aft in order to meet the required tipup margin as shown in this picture (forward is to the right).

For a commercial airplane with wing-mounted engines, assume that the c.g. is at the height of the cabin floor. The fuselage can be moved forward or aft relative to the wing to ensure that the c.g. travel matches the required limits on the m.a.c .

Lateral Tipover Margin

The critical lateral tip over condition occurs when the c.g. is at the forward limit. The 63^0 maximum turnover angle is determined by the requirements for a 1/2g turn on a taxiway.



The height of the c.g. (E) is transferred to the scrap view (VIEW A-A) in order to calculate the turnover angle. The scrap view is a view as if looking parallel to a line on the ground which passes through the center of the MLG bogie and the nosewheel (this is the approximate axis about which the airplane will rotate if it were to tip over). The scrap view can be set at an arbitrary distance from the plan view so that it does not interfere with the plan view.

Landing Gear Load Distribution

The non-dimensional nose gear load is calculated as

$$\frac{R_n}{W} = \frac{L_m}{L_m + L_n}$$

The value of this term should fall in the range from 0.08 to 0.15. If the load is less than 0.08 when the c.g. is at the aft limit, then the nosewheel has insufficient traction for steering. If greater than 0.15 when the c.g. is at the forward limit, then too much load is on unbraked wheels. If necessary, the value of L_n should be adjusted (i.e., the location of the nose gear) to bring the values within limits.

Center of Gravity Location

At this stage in the design process, the forward and aft locations of the center of gravity are still unknown. It may be assumed that the reference center of gravity is located at the quarter-chord of the m.a.c. Fig. 6-8 can then be used to estimate c.g. travel, which can be assumed to be centered on the reference c.g. location. In this figure the c.g. range for jet transports is too large. Better values to use are 20% for jet transports with engines on the wing, and 25% if the engines are on the rear fuselage.