Schaufele Annotations
Chapter 18 FAR Required Landing Field Length

Landing Profile

The landing profile from the screen height of 50 ft can be broken down into three segments:

- Approach descent at a constant speed of $V_{50} = 1.3\, V_{S_{app}}$ to the ground (without touching down)
- Constant altitude deceleration from V_{50} to $V_L = 1.2\, V_{S_{app}}$
- Touchdown and deceleration on the runway.

Stall speed in the landing configuration ($V_{S_{app}}$) is obtained from the low speed lift curves generated in Chapter 11. The procedure for calculating the distances for the three segments requires some explanation in addition to the description given on Schaufele pages 306 and 307.

An important simplifying assumption is that of an "effective" L/D on approach. This L/D includes the engine thrust on approach and this is normally close to idle. The effective L/D can be determined as the inverse of the assumed approach glideslope as shown in Table 18.1

Class of airplane	Glideslope (deg)	Effective L/D
Personal/Utility	14	4.0
Turboprops	7.1	8.0
Jet Transports	3.2	18.0

Table 18.1 Effective L/D

Air distance at constant speed from the screen height of 50 ft to the ground is therefore given by Schaufele Eq. (18-3).

For the second landing segment, an additional simplifying assumption is made that the value of $(L/D)_{eff}$ is constant throughout the deceleration, so drag is constant and:

$$D_{land} = \frac{W_{land}}{\left(\frac{L}{D}\right)_{eff}}$$

Air deceleration $$a_{air} = \frac{D_{land}}{\left(\frac{W}{g}\right)} = \frac{g}{\left(\frac{L}{D}\right)_{eff}}$$

Air deceleration distance $$d_{decel} = \frac{V_{50}^2 - V_L^2}{2a_{air}} = \left(\frac{L}{D}\right)_{eff}\left[\frac{V_{50}^2 - V_L^2}{2g}\right]$$

This is the second term in Schaufele Eq. (18-8). Note that in Schaufele, the variable 'a' in Eq. (18-4) refers to air deceleration, but in Eq. (18-5) it refers to ground deceleration.

For the third segment, the ground deceleration:

$$a_{ground} = \frac{F}{\left(\frac{W}{g}\right)}$$

where $F = \mu(W - L) + D$

where $\mu = 0.3$

$L = 0$

$D = C_{D_{RTO}} \frac{1}{2} \rho \left(0.7V_L\right)^2 S_{ref}$

The ground roll can be calculated as

$$S_g = \frac{V_L^2}{2a_{ground}}$$

This is the third term in Schaufele Eq. (18-8). $C_{D_{RTO}}$ is the aircraft drag coefficient in the rejected takeoff condition, with flaps and spoilers deployed. For lack of specific information on spoiler drag, spoilers can be treated as having drag equivalent to that of flaps, so that Schaufele Fig. 12-15 may be used . Although spoilers typically have a shorter chord than flaps, the flow behind the spoilers is completely separated. For initial calculations, a value of $C_{D_{spoilers}}$ = 0.0500 is reasonable (as was assumed for the example problem in Chapter 16). For more detailed calculation a spoiler drag of $C_{D_{\pi}}$ = 1.2 to 2.0 (with an average of 1.6), where $C_{D_{\pi}}$ is the drag coefficient based on spoiler frontal area (Ref. 18.1), should be used. The drag coefficient referenced to the wing reference area is $\Delta C_{D_p} = C_{D_{\pi}} S/S_{ref}$, where S for this case is the spoiler projected area.

Note that the FAR 25 landing distance is the demonstrated landing distance factored by 1.67. For the purposes of this analysis, it can be assumed that the calculated landing distance is the same as the demonstrated landing distance.

The maximum landing weight (MLW) depends on the design loads. Using data from Ref. 18.2, Table 3.3, MLW may be approximated by Table 18.2 below.

Aircraft Type	Ratio of MLW to MTOGW
FAR Part 25 certificated aircraft	0.84
FAR Part 23 certificated aircraft	0.98
Military transport jets	0.76
Military transport turboprops	0.84
Executive jets	0.88

Table 18.2 Maximum Landing Weight

These values should be used in the design exercise for this chapter.

References

18.1 Kundu, A.K., Aircraft Design, Cambridge Aerospace Series, 2010.

18.2 Roskam, J., Airplane Design Part 1, Roskam Aviation and Engineering Corp., 1985.