

Task VII.C: Soft Field Takeoff and Climb

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Lesson Overview

Objective

To familiarize the student with the proper procedures and techniques for soft-field takeoff and climb.

Reference

Aircraft Flight Manual / Pilot's Operating Handbook

Key Elements

1. Constant back pressure
2. Transfer weight from the wheels to the wings
3. Stay in ground effect until reaching V_y or V_x

Elements

1. Overview
2. Taxi
3. Takeoff Roll
4. Lift-Off
5. Initial Climb

Schedule

1. Discuss Objectives
2. Review material
3. Development

4. Conclusion

Equipment

1. White board and markers
2. References

IP Actions

1. Discuss lesson objectives
2. Present Lecture
3. Ask and Answer Questions
4. Assign homework

SP Actions

1. Participate in discussion
2. Take notes
3. Ask and respond to questions

Completion Standards

The lesson is complete when the student can demonstrate the knowledge of, and has shown proficiency in soft field takeoffs and climbs, with and without an obstacle and without the assistance of a flight instructor. The student must be able to maintain positive control of the airplane in ground effect until reaching the proper speed for climb out while demonstrating the proper use of checklists, traffic scan and safety procedures.

Instructor Notes

Attention

Have you ever got your car stuck off-roading? Why did it happen? So, what do we do when we have to takeoff an airplane in off-road conditions?

Overview

Review Objectives and Elements/Key ideas

What

A takeoff from a “soft” field - just like it says, we are attempting to takeoff from a soft, often uneven surface which could produce enough drag to prevent the airplane from reaching normal takeoff speeds.

Why

Soft surfaces or long wet grass can reduce the aircraft’s acceleration so much during the takeoff roll that adequate takeoff speed might not be attained if normal takeoff techniques were employed. As a maneuver, this will greatly improve takeoffs, landings, and aircraft control.

Lesson Details

Lesson Details

The soft field takeoff is essentially just a modification to the normal takeoff to account for the surface conditions being soft. These conditions add some additional goals to the takeoff which mandate that the aircraft be lifted off the surface as quickly as possible, and to transfer weight to the wings as soon as possible.

Soft conditions have a number of effects on the takeoff of the aircraft. Tall grass, soft sand, mud, or snow can impede the takeoff roll to the point where, in extreme circumstances, the aircraft might not be able to attain normal takeoff speeds. It is also often the case that soft surfaces are also rough surfaces which can damage the aircraft.

To accomplish the goal of transferring weight to the wings as quickly as possible judicious use of ground effect is utilized. This requires a degree of "feel" for the aircraft, and a fine control touch. Leaving ground effect prematurely can result in the aircraft settling back to the runway, or stalling.

Basic Technique

All of the normal admonishments about takeoffs apply (i.e. using proper runway incursion avoidance procedures, performing all pre-takeoff checks properly, etc.). In addition to the normal procedures as the aircraft enters the soft surface it should be kept moving at all times. Stopping risks having the aircraft bog down in the soft surface, or possibly even getting it completely stuck.

While moving on a soft surface back pressure on the controls should be maintained at all times. This reduces the load on the nosewheel and helps avoid it getting mired in the soft surface. With this in mind, during the takeoff roll the aircraft should do a slight "wheelie" keeping the weight off the nosewheel until liftoff into ground effect occurs. Once in ground effect, allow the aircraft to accelerate to a normal climb speed before allowing it to climb out of ground effect.

Technique Details

Taxiing

Once again, the bulk of what must be addressed during the taxi phase is the same as with a normal takeoff. If at a towered field don't cross the hold short line without a clearance, and if at an untowered field announce your intentions before entering the runway. Clear the area and insure proper runway incursion procedures are utilized. However, with a soft-field takeoff there will be no time to stop on the runway so a clear plan of how to proceed without stopping must be made prior to encountering soft surfaces.

Upon taxiing into an area with soft surfaces ensure that the controls are fully aft to reduce weight on the nosewheel. More power than is usually required may be needed to progress over the soft surface. Keep turns shallow, smooth, but don't stop as the aircraft may get bogged down if you do.

As the aircraft is taxied onto the runway continue moving as it is aligned with the runway

centerline. Don't stop! As the aircraft becomes aligned with the runway centerline smoothly apply full power. A quick glance at instruments to verify all are GREEN while maintaining directional control with rudder should happen early in the roll. Anticipate a slower acceleration due to the soft surface.

Common Errors

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- Insufficient back pressure resulting in inadequate angle of attack
- Failure to keep moving, bogging down the aircraft
- Failure to cross check instruments after applying power
- Failure to maintain directional control

Lift Off

Initially the elevator should be held full aft. As the aircraft accelerates and the nose lifts back pressure can be eased to maintain an attitude where the nosewheel is just off the ground (approximately a 5°-6° pitch angle). Too much back pressure as speed increases can result in a "tail strike" where the tail of the aircraft hits the ground. This can cause extensive damage and should be avoided. At all times maintain directional control with the rudder, not ailerons.

As speed increases weight will transfer to the wings. The reduction in weight on the wheels reduces drag from the soft surface and allows the aircraft to more easily accelerate. The aircraft will fly itself off the ground at a lower than normal rotation speed due to the ground effect, but must stay in ground effect until a climb airspeed is achieved.

After the aircraft is airborne the back pressure should be released keeping the wheels clear of the surface (i.e. it should be skimming along in ground effect feet above the surface). Allow the aircraft to accelerate to V_x or V_y depending upon prevailing needs such as the need to clear an obstacle on departure. Do not attempt to climb until reaching the desired airspeed as this could take the aircraft out of ground effect before it is actually ready to fly. During the time the aircraft is in ground effect use the rudder to counter any drift.

Ground effect is a condition where the down wash from the wing is impeded by the ground and it can be envisioned as a "cushion" of air being created under the wing. This cushion provides some additional lift which is what allows the aircraft to become prematurely airborne. However, moving away from this cushion (which rises only as high as about one wingspan from the surface) causes the aircraft to lose that cushion, and not have enough lift to stay airborne at that altitude. Thus the aircraft must accelerate to at least V_x prior to any attempt to climb out of ground effect.

Common Errors

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- Abrupt or excessive elevator movement while attempting to level off in ground effect
- Attempting to climb out of ground effect prematurely
- Allowing the aircraft to "mush" resulting in an inadvertent touchdown
- Failing to execute proper lift off procedures

Initial Climb

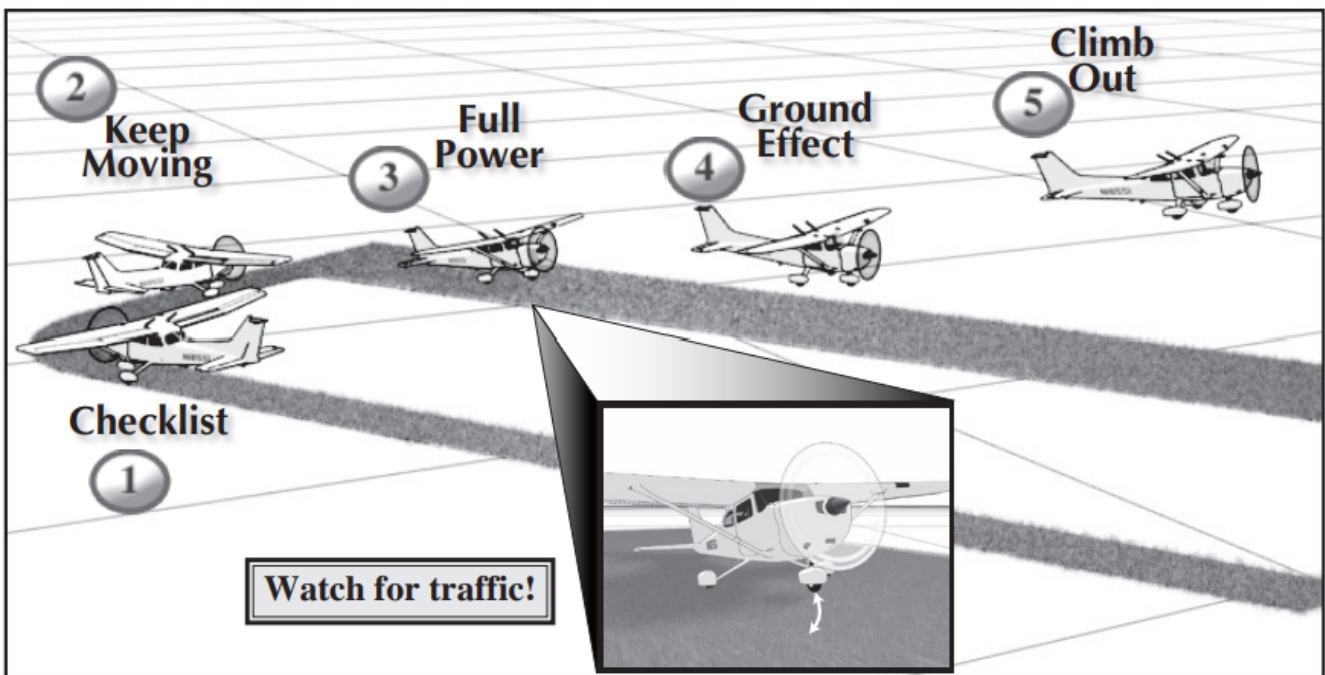
Once out of ground effect the climb is much the same as a normal or crosswind takeoff. Use the normal procedures for the takeoff based upon prevailing conditions. However, soft fields are often also short, therefore V_x is often the desired initial climb airspeed so that obstacles are cleared.

Other attributes of a soft field are that they are often soft due to wet or icy conditions. Therefore, if departing in an aircraft with retractable gear it is advisable to not retract the gear immediately (unless the extra performance is mandated by the need to clear an obstacle) so that it can "air dry" before being stowed. If the outside air temperatures are cold, consider cycling the gear a few times to insure it doesn't freeze in place once at a safe altitude to do so.

Procedure

1. Ensure that the Before Takeoff Checklist has been completed.
 - a. Set flaps as appropriate – ensure that flaps come down equally.
 - b. Maintain full up elevator while taxiing.
 - c. Ensure that the items on the Line-up Checklist have been completed and/or reviewed.
 - d. Visually check for traffic on Downwind, Base, and Final in the active and other traffic patterns.
 - e. Communicate, as appropriate – non-towered airport make traffic advisory call, towered airport read back takeoff clearance.
 - f. Taxi onto the runway, as appropriate. Complete the items from the Line-up Checklist while taxiing. Use the phrase "lights, camera, action" to help remember the items deferred (lights = lights as appropriate, camera = transponder on/altitude, action = mixture rich as required).
2. Keep the aircraft moving at a brisk pace while taxiing into position for takeoff – avoid braking and/or stopping. Keep heels on the floor unless braking is required.
3. Smoothly and positively apply full power. Keep a hand on the throttle in the event an abort becomes necessary.
 - a. Apply full back pressure until the nose wheel comes off the runway. Adjust back pressure to maintain the nose wheel clear of the runway and to avoid striking the tail.
 - b. Check engine instruments (engine rpm and all other "engine instruments in the green") and airspeed indicator ("airspeed alive").
 - c. Allow the airplane to lift-off when it is ready. Establish a Wind Correction Angle (WCA) to maintain the runway centerline with level wings.
4. Adjust pitch to accelerate to V_X or V_Y in ground effect.
5. Obstacle?
 - a. If No Obstacle is Present:
 - i. Establish V_Y pitch attitude.
 - ii. Retract flaps at safe altitude and airspeed.

- iii. Climb out at VY.
- b. To Clear Obstacle:
 - i. Establish VX pitch attitude.
 - ii. Continue climb at VX or manufacturer's recommended airspeed.
 - iii. Once obstacle is cleared, establish VY attitude.
 - iv. Retract flaps at safe altitude and airspeed.
 - v. Climb out at VY.
- c. Maintain a ground track along the runway and extended centerline with coordinated use of rudder and aileron. Establish cruise climb above a minimum safe altitude (500-1000' AGL).



Common Errors

- Improper runway incursion avoidance procedures
- Failure to adequately clear the area
- Insufficient back elevator pressure during the initial takeoff roll resulting in an inadequate angle of attack
- Failure to cross check engine instruments for indications of proper operation after applying power
- Poor directional control
- Improper lift-off procedures
- Climbing too steeply after lift-off
- Abrupt and/or excessive elevator control while attempting to level off and accelerate after lift-off
- Allowing the airplane to “mush” or settle resulting in an inadvertent touchdown

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after lift-off

- Attempting to climb out of ground effect area before attaining sufficient climb speed
- Improper climb attitude, power setting, and airspeed (V_x or V_y)
- Failure to anticipate a need to increase pitch attitude as the airplane climbs out of ground effect
- Improper use of checklists

Conclusion

Anytime we are taking off from a soft field runway, we need to as efficiently as possible get the weight off the wheels of the airplane and onto the wings, therefore reducing drag and allowing the airplane to accelerate to a safe takeoff speed before attempting to climb out, otherwise it may not be possible to accelerate to the speed required.

ACS Requirements

To determine that the applicant:

1. Exhibits instructional knowledge of the elements of a soft-field takeoff and climb by describing:
 - a. Procedures before taxiing onto the runway or takeoff area to ensure runway incursion avoidance. Verify ATC clearance/no aircraft on final at non-towered airports before entering the runway, and ensure correct takeoff runway positioning of the airplane with consideration for other aircraft, surface conditions, and wind.
 - b. Soft-field takeoff and lift-off procedures.
 - c. Initial climb attitude and airspeed, (V_x , if an obstacle is present (50 feet AGL), or V_y).
 - d. Proper use of checklist.
2. Exhibits instructional knowledge of common errors related to a soft-field takeoff and climb by describing:
3. Improper runway incursion avoidance procedures.
4. Improper use of controls during a soft-field takeoff.
5. Improper lift-off procedures.
6. Improper climb attitude, power setting, and airspeed (V_y or V_x).
7. Improper use of checklist.
 - a. Demonstrates and simultaneously explains a soft-field takeoff and climb from an instructional standpoint.
 - b. Analyzes and corrects simulated common errors related to a soft-field takeoff and climb.

Private Pilot ACS Skills Standards

1. Complete the appropriate checklist.
2. Make radio calls as appropriate.
3. Verify assigned/correct runway.
4. Ascertain wind direction with or without visible wind direction indicators.
5. Position the flight controls for the existing wind conditions.
6. Clear the area, taxi into takeoff position and align the airplane on the runway centerline without stopping, while advancing the throttle smoothly to takeoff power.
7. Confirm takeoff power and proper engine and flight instrument indications prior to rotation.
8. Establish and maintain a pitch attitude that will transfer the weight of the airplane from the wheels to the wings as rapidly as possible.
9. Lift off at the lowest possible airspeed and remain in ground effect while accelerating to V_x or V_y , as appropriate.
10. Establish a pitch attitude for V_x or V_y , as appropriate, and maintain selected airspeed $+10/-5$ knots during the climb.
11. Retract landing gear and flaps after a positive rate of climb has been verified or in accordance with aircraft manufacturer's guidance.
12. Maintain V_x or $V_y +10/-5$ knots to a safe maneuvering altitude
13. Maintain directional control and proper wind drift correction throughout takeoff and climb.
14. Comply with noise abatement procedures.

Commercial Pilot ACS Skills Standards

The same as the Private Pilot, except:

1. Establish a pitch attitude for V_x or V_y , as appropriate, and maintain selected airspeed $+/-5$ knots during the climb.
2. Maintain V_x or $V_y +/-5$ knots to a safe maneuvering altitude