Slipping surely the Surly Bonds
— taking off in the Tiger Moth

Martin Burdan continues his series on aspects of flying vintage aeroplanes. While these discourses are aimed especially at the newer Tiger Moth pilot, there are lessons to be learned — preferably the easy way — by all people who take to the air.

WHETHER FLYING a kite, Tiger Moth or 747, the takeoff is one of the most critical manoeuvres in aviation and needs to be regarded as such on every occasion. Takeoff begins the age-old dream to defeat gravity, but remember gravity will always be keen to conspire with other events to prevent success.

So, as with all aspects of flying, the prelude to consistently safe and successful takeoffs is planning. Get your head around every takeoff. Don't rely on subconscious responses shaped by the predictable and familiar events of your experience. Rather, keep in mind conscious reactions to the unpredictable which is forever waiting to test inexperience. If the unforeseen occurs, successful outcomes will be measured by how well you are mentally prepared. On takeoff assume nothing will be normal and be pleasantly surprised when it is.

Think about wind. Always. Check the windsock as you line up to confirm wind direction. Establish expectations regarding the effects of wind strength, any veering, gusts, or crosswind. Consider a decision point for abandoning the takeoff. Be prepared to act upon it if performance is adversely affected by lack of wind, tailwind, slope, soggy ground, long grass, heavy load, density altitude or whatever. Lining up is the important time to note carefully any potential takeoff problems and put yourself ahead of unfavourable events rather than behind.

Line up only when you can takeoff immediately thereafter. If there is any delay, hold the aircraft at an angle to the runway. This will be the clearest view of the runway you'll get in a Tiger Moth at any point in the takeoff, and ensures when rolling that the way is clear ahead. The time to see the aircraft which has stopped in front of you is not on full song when you raise the tail.

Never rush opening the throttle. Be sympathetic towards the large mass, long stroke Gipsy Major which will need more time to spool up than your average Toyota. It's also likely to express its lack of appreciation with a rich cut if you are inconsiderate. When opening the throttle count deliberately, "One hundred, two hundred, three hundred", and this is the minimum time it should take to reach full throttle. Be aware of the extra force required to open the carburettor heat butterfly beyond the two-thirds throttle-open position. The return spring resistance at the point the butterfly opens can be mistaken for full throttle.

Tail down, the Tiger is rather blind straight ahead and only marginally better once the tail rises (depending on the size of your passenger's head). It can help to get your head out one side when beginning the takeoff roll to provide at least some forward vision and reference points against which to check any developing swing. Aim, however, to be ambidextrous in looking out either side comfortably. You'll want to look out the into-wind side in a crosswind, and the wind won't always be coming from the left if you've made that your preferred side. Being able to change sides during takeoff (or landing) is also important to counter the inevitable passenger who will poke his head out and block your forward view at the worst possible moment.

Takeoff is the process of convincing an aircraft to convert smoothly from a ground machine to a flying machine. During this time, as long as a Tiger's wheels contact the ground, characteristics which can make it difficult to taxi are eagerly waiting to make themselves felt, and will do so if allowed.

A combination of factors produces longitudinal and lateral instability. Consider some 140 lbs of fuel in the tank perched 9 ft in the air, 330 lbs of engine hoisted 6 ft up, a similar weight of human habitation not much lower, and all pivoting around a narrow set of wheels. Now put the centre of gravity immediately behind those wheels and the ground stability package has similarities to a three-wheel double-decker bus with all the passengers on the top deck, except that the Tiger won't willingly drive in a straight line or offer panoramic forward visibility.

More significant is the short longitudinal distance between the undercarriage and the C of G. Let it shift forward of the main wheels by getting the tail too high and the Tiger will quickly reach its desired state of equilibrium — on its back and sliding tail first. Careful consideration and management of a Tiger Moth's inherent ground instability is fundamental to smoothly slipping the surly bonds.

With this in mind, care must be taken in getting the tail up during the takeoff run. The stick should be aft of neutral at the point of opening the throttle. During throttle opening it's safer for the stick to follow the throttle forward, rather than moving the stick ahead of the throttle. This will give more accurate control of the tail lifting procedure, and lessens the chances of the tail rising too rapidly and perhaps getting too high with embarrassing and expensive consequences only moments away.

The speed with which the tail rises will vary, depending on a combination of factors: weight aft of the C of G, wind speed, power setting and elevator input. Power setting will be a constant progression towards full throttle, but the other three factors are more variable. For example, with an empty luggage locker and 15 knots on the nose, the tail will rise with relative enthusiasm, compared with a no-wind, fully loaded situation where it will take longer and need greater initial elevator input to rise into position.

The fully forward stick position should rarely be required in getting the tail up at a satisfactory pace, other than such situations as a fully loaded luggage locker and with little wind. Here, anything less than full forward elevator might mean sluggish or insufficient lifting of the tail.

The tail therefore needs to be "felt" up with the stick on takeoff, keeping in mind wind speed and aircraft loading. If the stick is just automatically shoved fully forward and left there with full power, the Tiger will readily bite the dust. It's preferable to steadily move the stick forward. As you feel the elevator begin to take effect and the tail rises, be prepared to adopt quick and sensitive

responses for the moment of halting the rising tail by checking slightly back on the stick. (Don't check back too much though, or she may lift off prematurely.) Remember that the Tiger elevator becomes increasingly effective as the speed builds during takeoff, and things happen rapidly and at once.

Take care, on the other hand, not to be too cautious in raising the tail. If the tail is too slow in rising or allowed to remain low, the Tiger will mush into the air in a nose-high attitude and with very little airspeed. Any gust, drop in wind speed or misuse of the rudder could rapidly lead to a stall at a height you don't want to practise stall recovery.

Asymmetric thrust, torque reaction and slipstream effects all play a part in the Tiger wanting to veer right on takeoff. Although the effects of the fourth player, gyroscopic precession, are not large on a Tiger Moth, the tendency to swing to the right will be most marked during the time when the tail rises. Be ready to use left rudder as necessary. Rudder area is generous on the Tiger and with full propeller draught any swing is easily corrected, at least in the early stages. Be aware that the faster the tail rises, the greater the tendency to swing. This becomes especially noticeable on more powerful taildraggers with a much larger propeller and engine mass spinning up front.

Once the tail is rising care must be taken in establishing and maintaining the correct fore-and-aft attitude. The correct takeoff position is a slightly tail-low attitude, one in which the aircraft will naturally fly itself off. Never let the tailplane rise above parallel to the runway. This avoids daring that high C of G towards the critical point where it will rapidly shift ahead of the main wheels, at which time the pilot becomes an unhappy passenger. Forget about raising the tail to try and see over the nose. The only decent view you'd get would be briefly before the dramatic 180 degree direction change. Keep the tail under control, the C of G comfortably behind the main wheels, and the day stays pleasant.

As seen from the cockpit (more easily the front cockpit) a reference point for confirming the correct attitude is the top line of the nose cowl. The cowl droops approximately five degrees in relation to the longerons, so if this is aligned horizontally the tail must be positioned suitably below the horizontal. Get someone to lift the tail on the ground so you can see the correct position.

Although less practical, another visual reference is the wing tip chord as seen from the cockpit. This should never reach the horizontal. If it did the angle of incidence would be zero which better suits descent rather than ascent. Of more immediate concern would again be the tail-high attitude with the C of G teetering about the main wheels and the propeller about to assume a short-lived career as a rotary mower blade.

The tail will rise more quickly as the wind increases in speed. A gust of wind on the nose will suddenly increase elevator effectiveness, requiring rapid stick compensation if the elevator is still forward in the process of lifting the tail. Stay alert because a decent gust will easily tip the Tiger on its nose. Note that this is quite different to a tail wind picking up the tail which could occur taxying with incorrect elevator management in gusty conditions.

At any stage in the takeoff run, patches of soft ground, water or long grass will suddenly increase the drag on the wheels and therefore the tendency for nosing over — another good reason for never allowing the tail to rise above the horizontal. Be prepared for any change in the surface of the grass.

After lifting off, hold the aircraft in ground effect, check that the airspeed is rising and let it build up to 66 mph before assuming the climb attitude. Raising the nose in any aircraft will cause the airspeed to drop. In a high drag aircraft like the Tiger, airspeed plummets enthusiastically when the nose is raised. Don't be caught out low and slow by automatically hauling back on the pole after liftoff.

Be particularly focused on EFATO actions in the first 1000 feet. From the moment you are airborne, assess and continually reassess the most favourable landing spots should the dreaded silence occur. Thinking ahead will result in a controlled arrival with minimum forces involved and therefore maximum success.

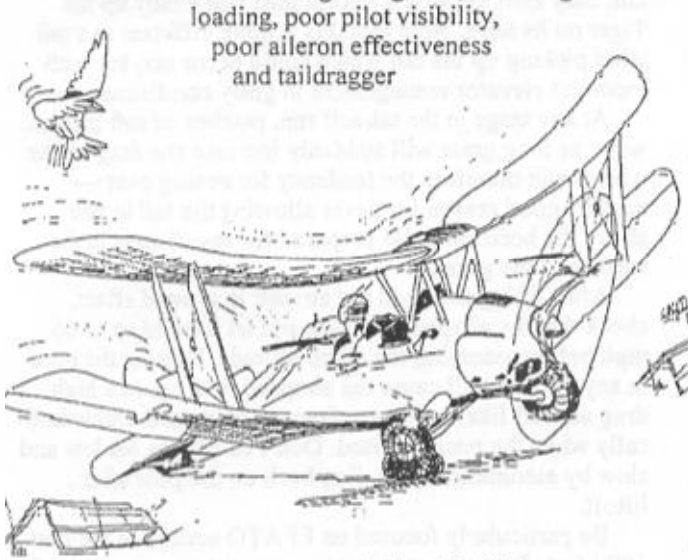
Now you can enjoy the flight until the next critical bit, the landing!

Seeking surely the surly bonds — Landing the Tiger Moth

by Martin Burdan

Having slipped the surly bonds, the hard part to flying any aeroplane must now eventually follow — getting down again. Landing involves coaxing the Tiger Moth out of its natural airborne element onto the ground, an unfavourable environment for which it was never primarily designed. An aircraft, foremost a craft-of-the-air, has craft-of-the-ground design considerations of secondary importance and this noticeably applies to the Tiger.

The main challenges to successful Tiger Moth landings involve its large wing area, low wing loading, poor pilot visibility, poor aileron effectiveness and taildragger design. We'll focus on taildragger features first and consider the other obstacles during specific landings.



The advantage of the taildragger configuration is its simplicity. It avoids the weight and drag penalties of a nose wheel and associated engineering complications. When moving along the ground, however, taildragger aircraft display a distinct disadvantage in that they are directionally unstable. The chief culprit for instability is the C of G position behind the main wheels, whereas tricycle undercarriage aircraft have a stable C of G position in front of the main wheels. Let's now look at how the taildragger C of G position conspires to make landings harder work.

The approach has been good and we've touched down right on the chosen spot. Assume the main wheels touch first. With the C of G behind them, any vertical sink at touchdown will tend to lower the tail. This raises the angle of attack, increases lift and suddenly we're flying once more. The greater the vertical sink, the more spectacular the reaction, from both the aircraft, onlookers and our heart rate.

We call this embarrassing condition a "bounce", but actually it is not the undercarriage "bouncing" the aircraft back into the air. The undercarriage plays little part. It is the increase in lift brought about by the change in angle of attack which literally flies the aircraft back into the air. Only briefly, of course, unless we promptly apply power, which is the safest response if the bounce is high. If not, by the top of the bounce any useful remaining airspeed quickly evaporates and the need for a large trailer rapidly approaches.

By contrast, with a tricycle undercarriage, the laws of physics work for the pilot in minimising rather than magnifying error. This time any vertical sink at touchdown will lower both the nose and angle of attack. This decreases lift and helps plaster the aircraft to the runway rather than rejecting it.

The taildragger C of G position behind the main wheels continues to be unhelpful in creating directional instability. A taildragger will not naturally roll in a straight line and is in fact more directionally stable rolling tail first. The constant footwork, like that of the unicyclist wanting to remain upright in one spot, is to prevent the tail forever trying to overtake the nose.

And the physics get even more unhelpful. Should any swing develop, it will tend to rapidly increase by virtue of the C of G position. Beyond a certain point a swing cannot be stopped even by all available means, just as our intrepid unicyclist knows he must fall if his feet let the C of G get away. Instability tends to seek resolution and, if given the chance, a taildragger will demonstrate this fact with the dreaded ground loop.

Again in contrast, the tricycle undercarriage C of G position between the main and nose wheels means its natural condition is to roll in a straight line. Should a swing develop, the momentum of the aircraft acting through the C of G continues to be helpful by tending to straighten things out.

In summary, there are two things to remember for successful landings in any taildragger. Firstly, touch down with minimum sink to prevent bouncing, particularly if the main wheels touch first. Secondly, touch down without drift, subsequently keeping feet working to minimise heading deviation and prevent loss of directional control. Tricycle configuration will tend to smooth errors in both respects whereas taildragger configuration will worsen errors.

Now let's consider the basic two types of landings to choose from in a Tiger Moth: three-point or two-point wheeler.

Three-point landings

Three-point landings stem from the early days of aviation when airframes, particularly undercarriages, tyres, springs and shock absorbers, were not as strong and effective as they later became. It was important to keep component loads to a minimum and a touchdown at the lowest possible speed best satisfied this requirement.

With a three-point landing the angle of attack cannot be made to increase. This avoids the possibility of the embarrassing airborne rebound. A three-pointer uses the least amount of runway, an important consideration in respect of a successful forced landing in restricted terrain. Remember, landing distance increases as the square of the speed, as do impact forces if there is a sudden stop.

Three-point landings are also a great technique for honing our Tiger flying skills. And what could possibly match the feeling of satisfaction that comes with greasing a Tiger on in a perfect three-pointer?

Graham Gilliver

Three-pointers in a Tiger are best suited to light, steady, predictable, on-the-nose winds up to about 10 knots. In the semi-stalled, low airspeed, high angle of attack attitude required to immediately precede a successful three-pointer, the Tiger is extremely vulnerable to any change in wind speed or direction. In a gust, a combination of low airspeed, high angle of attack, large wing area and low wing loading can quickly balloon the aircraft to an unhealthy height above the ground.

Suddenly the gust lulls, the newly acquired lift evaporates and the pilot rapidly assumes a spectator role. Poor aileron response at low speeds doesn't help control in situations where strong and unpredictable winds exist. Forget about a three-pointer in these conditions. Two-point wheelers provide much safer margins.

The easy bit to the classic three-point arrival involves stalling a Tiger Moth at the lowest possible airspeed. The tricky bit is organising this event one inch above the ground. However, as with many taildraggers, a favourable design aspect means the aircraft will stall onto three points exactly when the stick is hard back. The practice comes in judging the round out height and rate of rearward stick travel to achieve the stick-hard-back/stall combination at precisely the right moment.

Two factors we may at first find troublesome in achieving a three-point stall from the correct round out position. Firstly, compared with some taildraggers like the Cub, the Tiger nose attitude seems alarmingly high in the three-point position. Climb from the front of a Cub into the back of a Tiger and the nose seems to arc upwards forever. Partly this is because the pilot is seated almost halfway down the length of the aircraft and so there is more aeroplane ahead. It's also because the angle at which a Tiger sits relative to the ground is greater than a Cub's. Therefore there is a greater angle to rotate the airframe from level flight to three points. This can be disconcerting at first.

The second challenge in three-pointing is linked to the first and concerns lack of forward visibility. In level flight, although cluttered by struts, wires, windscreens and perhaps a passenger, there is at least some view over the nose. However, as round out begins and the nose is steadily raised to stall the aircraft, this comforting visibility ahead disappears and drift must be assessed by less instinctive means. Compare it to driving a car. Accurate position can be easily maintained by looking directly ahead. Now imagine blotting out the windscreen and remaining on the road at 50 mph by staring thirty degrees off track through the side window. This is effectively what is required in landing a number of taildraggers.

We can, however, cheat a little in the Tiger Moth. While the original Tiger harness design has little safety-wise to recommend it, one point in its favour is that it allows the pilot to lean out either side. In doing so there is some forward view along one side of the fuselage. So, as with taking off, it can be helpful to get our head out one side from round out height to establish easier forward reference points against which drift and swing can be checked. Scanning the runway ahead aids binocular vision for accurately assessing height during round out. This can also be simpler looking out one side.

Let's fly a three-point landing. Trimmed and trickling over the threshold at 66 mph, we close the throttle to round out and move our head out one side. Later, with more experience, we will be able to cope without poking our head into the breeze, but for now this is helpful. We've had our last glance at the ASI and now the rest is done by feel and outside reference. The aircraft at this point is flying just a few feet above and parallel to the runway. Slowly begin easing back on the stick, always with direct visual reference to the ground. Too quickly and the aircraft will rise, too slowly and she will settle early on two points.

The airspeed is constantly bleeding off. Therefore the speed with which we move the stick back will steadily increase from an imperceptible movement at first to one which is quite rapid momentarily before the stall. There is some reluctance with the first few landings, as the nose looms progressively above the horizon, to avoid pulling the stick back that last little bit. However, anything less than hard back on the stick and the Tiger will typically not three-point. We have to suppress instincts strongly suggesting this is not a healthy situation — stick in the guts, high nose, very quiet, no airspeed, little visibility ...! Which is why we create this situation only above 3000 feet or below one inch, in winds on the nose and under 10 knots.

Great! An arrival so smooth we barely noticed. Of course on such occasions no one else will have either, but let's not get distracted just yet. The landing is not over until the aeroplane is in the hangar with the doors closed. The instant the wheels touch we're no longer flying an aeroplane but driving a shopping trolley at 45 miles per hour. The C of G, benignly compliant in the air, is suddenly poised to actively assert itself.

After touchdown, nail the stick hard back to keep the tail on the ground. This improves tail skid friction for both stopping and steering. Now concentration must focus on keeping the nose straight as the stroppy C of G argues to lead the wheels rather than follow. The Tiger has a relatively long fuselage and reasonable undercarriage width, so it isn't as twitchy as some short-coupled taildraggers. However, the nose position still needs constant assessment. The barest movement from track must be caught with rudder; let the nose wander too far and it may not be retrievable, even with full rudder and power. If we are slow responding to nose movement then our eventual rudder response will need to be greater. This can lead to over-controlling and that unhelpful C of G rapidly getting its way.

Keep rudder movement reactive rather than proactive. We don't need to pedal feverishly for the sake of it, but the pilot who has flown only trikes may at first overreact as dormant feet awake. In balancing a broom on one finger the hand moves in response to movement of the broom head to catch it from falling. There is no need to wiggle the hand in anticipation. Similarly, focus on reading the nose and catching it, rather than thinking about the rudder. Only do whatever needs to be done with the rudder to prevent the nose from moving. There will be small, fairly rapid rudder movements in keeping straight, but all in constant response or correction to yaw, not anticipation.

Practise looking out both sides when landing. This accounts for that passenger who also likes to see ahead, blocking the view by poking his head out just at the wrong moment. My most colourful recollection of having to abruptly change sides was during round out when my face intercepted the passenger's full sick bag. With a last minute flash of inspiration my brother had decided it would be a good idea to get rid of his soggy evidence before we taxied in.

Two-point wheeler landings

Wheeler landings are essential for higher winds, gusty winds or crosswinds. This type of landing provides both greater visibility and control in unpredictable winds. Touching down with the tail up means the angle of attack

is lower and any gust will, at least initially, have less influence on ballooning the aircraft. By breaking the arrival into two distinct phases, main wheels followed by tail skid, the landing process is spread out. This gives greater time to monitor the situation as it unfolds, with options available if required at any stage.

A Tiger will wheel on nicely from a glide approach in steady, predictable winds. Continue the 66 mph glide until round out. Flare at the appropriate height to assume a slightly tail low touchdown attitude, the same as for takeoff. Aim to touch down around 60 mph because less speed will allow the tail to begin settling. If the tail is too low we lose the benefits of touching down with greater forward visibility, reduced angle of attack and easier control over vertical sink. If the tail is too high at touchdown we risk going over on our back.

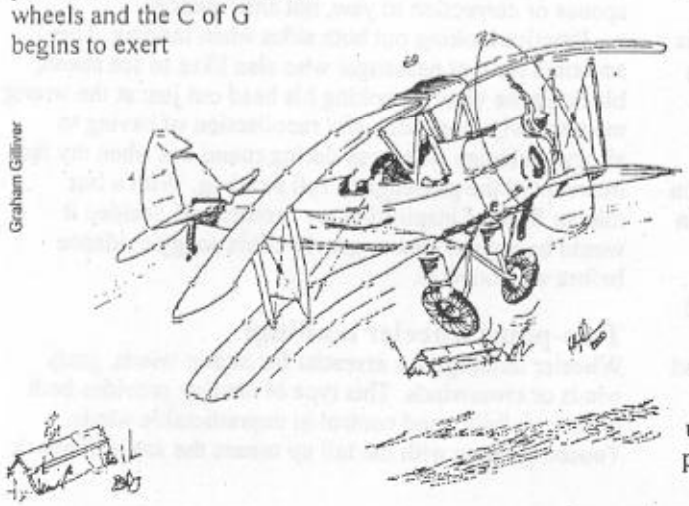
Wheel on with power during windy days when the air near the ground may be turbulent. A trickle of power helps keep the tail feathers alive, providing more immediate elevator and rudder response to allow finer control throughout. With power on, below 55 mph the tail will begin settling, so avoid lower speeds at touchdown.

In lively, gusty conditions it's important to get the wheels on the ground under the fullest control possible. The difficult bit is the transition point from round out height down to the ground. The worst possible situation to face is being pounded around with poor control while low and slow. The best way to stay ahead of the whims of the wind is to adopt a flatter, powered approach and increase the airspeed.

Ailerons are the least effective control in a Tiger and the airspeed will need to exceed 66 mph to maintain useful aileron response if things are really lumpy. Sustain this speed until over the fence, when focus moves entirely beyond the cockpit. While the aircraft will still have flying speed at touchdown, ground speed will be much lower and both will rapidly wash off. Greater runway length will be required, although this will at least be partly offset by the forward wind component. The significant thing this technique allows is greater elevator, rudder and particularly aileron control, as well as time to judge the conditions and go around at any point if necessary.

Close the throttle the moment the wheels touch. At this point we must be highly sensitive with the stick. Taildragger pilots are sometimes advised to check forward on the stick at touchdown. The idea is that this reduces lift by decreasing the angle of attack, thereby holding the wheels on the ground.

This is not a safe technique in a Tiger Moth. Remember that the C of G is also high in a Tiger. Move its position forward of the main wheels and the C of G begins to exert the sort of leverage that will easily win an argument with the elevator trying to hold it back. Friction between the grass and the wheels as they touch will tend to raise the tail anyway, and this effect will be greater touching down in a soft patch. Checking forward on the stick risks putting a Tiger on its back.



Graham Gilliver

A safer method is to fly the right approach, aiming to achieve the correct combination of airspeed and sink in the flare. Let the Tiger fly parallel to the ground momentarily before touchdown, with a low rate of sink, and it will not need to be plastered to the grass by poling forward on the stick. A Tiger undercarriage is very forgiving and will absorb a reasonable range of arrivals without rebounding the aircraft. Rather than thinking "check forward" as a cure to an inaccurate arrival, work on achieving the correct round out profile and then simply relax pressure on the stick as the wheels touch.

Having greased the wheels on, hold the stick in the touchdown position, allowing the tail to lower of its own accord. Follow the tail down with the elevator, rather than leading it. Leading the tail down risks ballooning. Once the tail has settled, smartly pull the stick hard back to hold it on the ground.

After touchdown, do not keep the tail up by progressively pushing forward on the stick. This technique applies to some aircraft with brakes, where maintaining a shallow angle of attack and moving the C of G closer to the main wheels allows greater braking effect. However, in a Tiger with the tail up, the elevator well down and a high C of G, the greater danger is putting it on its back with the help of a gust or soft patch of grass. Also, with the tail up rudder control becomes less effective with reducing airspeed, leaving directional control increasingly marginal. The tail is better lowered naturally and pegged to the grass as early as possible.

Take care with two- or three-point touch-and-goes, where coarse use of forward stick as power is applied may initiate a nose over. This is because the existing forward speed airflow means a more lively elevator response when the throttle is opened compared with taking off from a standing start. If the tail is already airborne after a wheeler landing, there is no need to pole forward in rote fashion upon opening the throttle. Simply do with the stick whatever is the minimum required to achieve and maintain the correct takeoff attitude.

If caught out by high winds, land directly into wind and as close as possible to a source of wing tip assistance. Do not accept any crosswind component as there will be enough work without it. This may mean ignoring the conventional runway system of an airfield and choosing instead the most appropriate into-wind patch of grass or seal. In a decent wind it won't need to be any great length, but it must be checked for obstacles with consideration for a safe overshoot.

Attempting to taxi after having landed successfully in high winds will ensure some exciting moments, and may result in the aircraft being blown upside down. It's safer to remain headed into wind with the engine running until wing tip assistance arrives. If the wind is so strong that the wings begin lifting, carefully move the stick forward to raise the tail thereby lowering the angle of attack and reducing the lifting effect.

Take care however, as gusts can make the situation unpredictable. If the aircraft lifts, do not hesitate to apply power and fly her off. Go around and try again.