

BRACE ASSEMBLIES FOR WIRE FENCES

What They Are - How They Work - How To Construct Them

When constructing wire fences, brace assemblies are required to anchor the wire. They are designed to be able to resist the loads that are transferred from the tensioned fence wires and are constructed on-site using fence posts and fence wire. This factsheet outlines background information to help understand fence braces.

Refer to Factsheet 307.220-2 *Brace Assemblies for Wire Fences – End, Inline and Change-of-Direction Braces* for details on types of braces and selecting braces to use for fence conditions.

FUNCTION AND DESIGN OF BRACES

Corner, end and inline brace assemblies are the foundation of a good fence. The failure of one such assembly may result in the failure of a whole section of fence. Particular attention must be given to details such as location in suitable soils, depth of post placement, connection of the rail to the posts and tying off of the wires.

What is a Brace ?

A brace is a made-on-site anchor assembly consisting of one or more posts driven into the ground connected with one or more rails and tensioned together with wire. It forms the tie off point for the fence wire. It is named for the number of driven posts it requires, i.e. a two-post brace has two posts driven into the ground (and is completed with a rail and tensioned brace wire).

What is a brace really doing ?

As a brace assembly is an anchor point it must withstand all the load from the fence wires. Under normal conditions, the tensioned fence wires will exert a pull on the brace of 1,000 to 1,500 lb. With cold weather contraction the pull may be as much as 2,500 lb. In addition, shock loads to the wires, such as from livestock pushing or fallen trees, also have to be withstood.

In barbed wire fences, some of the load is absorbed by line posts when the barbs catch at staples. In smooth wire fences, with line wires not stapled “home”, the total fence load is transmitted to the brace assembly.

A brace must withstand the fence loads by transferring them to the earth. This means a brace is a combination of **structure and soil** - both are important for an effective brace. A brace can fail in one or more ways, by:

- structure failure (broken post or rail)
- soil failure (soil shear in front of the post allowing the post to move)
- end post pull out (indicating poor brace design for the soil conditions)

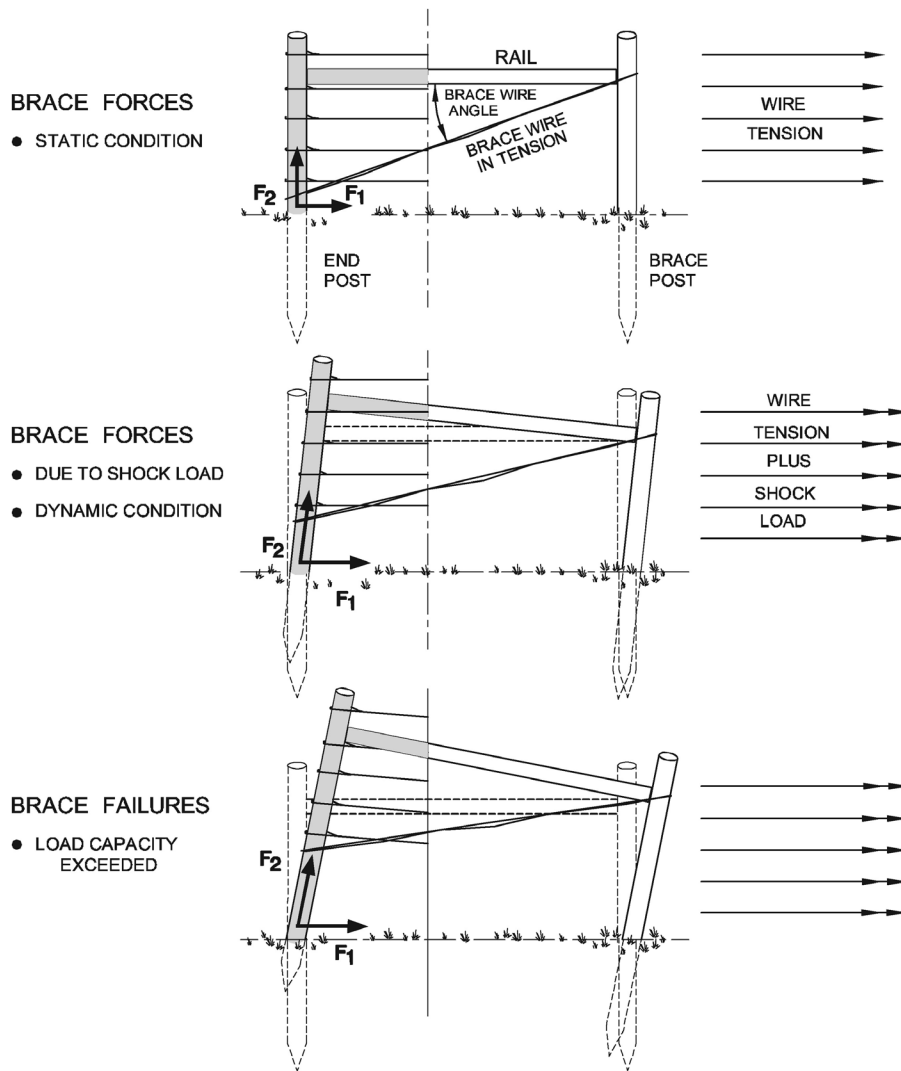


Figure 1 Forces in a End Brace Assembly

What are the forces in a brace ? Figure 1, above, illustrates the forces on a typical two-post, horizontal rail end brace. It can be seen that the fence wire tension load tends to bend the end post slightly, which, through the rigid rail, also bends the brace post. Movement of the top of the brace post adds tension to the brace wire, transferring part of the load back to the bottom of the end post.

The effect on the end post of this load transfer is in relation to the angle of the brace wire. This transferred load can be broken down into:

- a horizontal force F_1 trying to move the end post through the soil
- a vertical force F_2 trying to pull the end post out of the soil

The “steeper” the angle of the brace wire, the greater this vertical pull-out force. This is why short span braces (with “steeply” angled brace wire) may fail at low fence loads by end post pullout. Longer span braces (with “lower” angled brace wire) apply more horizontal load to the soil and post, failing at higher loads. Longer span braces will use the full load bearing capacities of both the soil and the post. This added strength can also be achieved by lowering the horizontal rail and therefore the brace wire angle.

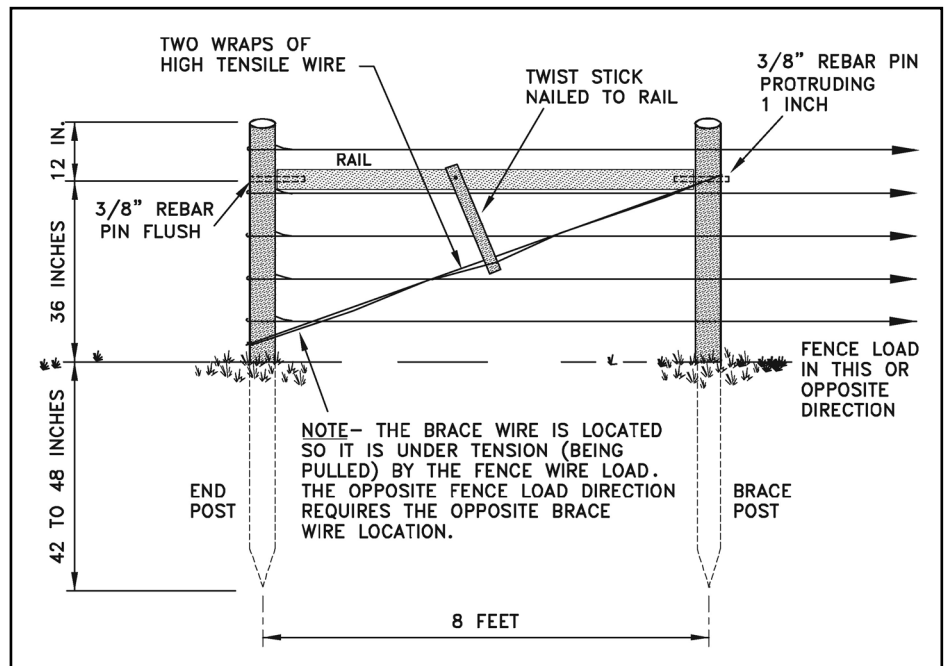


Figure 2 Typical Two-Post Brace Assembly

What size should a brace be ?

Short and long as used in the previous discussion are relative terms. As a rule, a brace should be 2 ½ times as long (between each driven post) as the height of the fence (if the rail is located at fence height). Therefore, for example, a fence brace should be ten feet long for a four foot fence height.

To avoid having to use a ten foot rail, use a shorter rail, set lower between the brace posts. A rule-of-thumb is to use a rail 2 times the fence height, set at ¾'s of the fence height. The example brace is then eight feet long and the rail at three feet from the ground on four-foot high brace posts. This uses economical common sized posts to achieve full strength. This is considered the standard brace portions and is shown in Figure 2, above.

Where to locate a brace ?

A brace is required wherever an anchoring point for the fence wires is needed. Some of these points are dictated by the terrain (dips, rises, etc.) or things like gates. Otherwise, braces are installed at the appropriate wire tie-off distances (660 ft. for barbed or woven wire - 1320 ft. for smooth wire).

What types of braces are used ?

A wide variety of brace designs have been used. Table 1 illustrates designs that have been proven effective. To be effective in resisting fence loads, these designs must be properly constructed and installed in suitable soils.

All the designs have a tie off post (shown larger) that is braced in front, in rear or in both directions to resist movement. Other designs not shown may have the required strength but generally are either too costly, too difficult to construct or both.


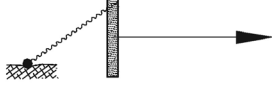
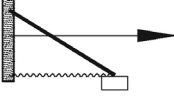
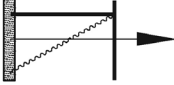
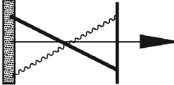
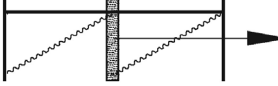
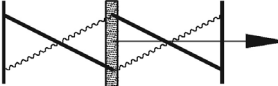
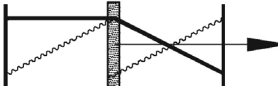
Tests conducted by various researchers indicate that two-post brace assemblies under favorable soil conditions are capable of withstanding loads from 3000–6000 lb. of pull; whereas, three-posts assemblies are capable of almost double that capacity. In good soil conditions, a two-post brace assembly will be adequate for fences of 6 line wires or less.

In soils of low cohesive properties, such as sandy, very wet plastic clays or peats, or when using more than 6 line wires, three-post brace assemblies are used. Refer to Factsheet 307.220-2 *Brace Assemblies for Wire Fences – End, Inline and Change-of-Direction Braces* for details of the braces in Table 1.

Table 1

STANDARD END BRACE ASSEMBLIES

(See brace details in Factsheet 307.220-2 *Brace Assemblies for Wire Fences – End, Inline and Change-of-Direction Braces*)

| Type of Brace | Diagram | Comments | Page (of Factsheet #307.220-2) |
|---|---|--|--|
| Single-post |  | For 1–3 low tension wires, i.e., electric fences. | page 1 |
| Single-post, deadman anchor |  | Requires suitable anchor. Simple with good load rating. Possibly equal to double span with suitable soil and deadman anchor. | page 3 |
| Single-post, diagonal brace (“Kiwi” brace) |  | Diagonal must be able to move freely on slider. | page 4 |
| Two-post, horizontal rail |  | Standard for 6 wires or less. Easy to construct properly. | page 5 |
| Two-post, diagonal rail |  | For 6 wires or less. Requires good rail-to-post connections. | page 6 |
| Three-post, horizontal rails |  | Standard for over 6 wires or poor soils. Pull from centre. | page 7 - 8 |
| Three-post, diagonal rails |  | For over 6 wires or poor soils. Requires good rail-to-post connections. Pull from centre. | pages 8 - 9 |
| Three-post, mixed rails |  | For over 6 wires or poor soils. Requires good rail-to-post connections. Pull from centre. | page 9 |

↑ ALL FENCE WIRES ARE TIED OFF ON THIS POST

Where to tie off on a brace ?

Normally, the fence wires are tied off on the end post when two-post assemblies are used. To achieve optimum strength using three-post assemblies, line wires are tied off at the **centre post** and the rear panel is "slack" wired. This is to prevent any misalignment of the three driven posts from causing brace failure. Pulling from the center post of a two-post brace can actually re-align the posts whereas pulling from the rear post will cause buckling and failure. Table 1, page 4, indicates proper wire tie off locations.

What are the factors in brace rigidity ?

Some factors effecting the rigidity of a brace (in similar soil conditions):

- the deeper the post is set into the ground, the greater the load capacity
- the larger the diameter of the post the greater the load capacity
- a post driven into undisturbed soil has a greater load capacity than one placed in an over-sized hole and filled by ramming
- dry and clay type soils generally have more resistance than wet and sandy soils

A properly built three-post brace assembly has a greater load capacity than a two-post assembly, but is generally only required in poor soil conditions.

When are double brace wires used ?

Some braces, such as inline braces located in straight fence runs, anchor wires that pull in two directions. In these cases a diagonal tension wire is installed on the brace to resist each load. It is important that these two diagonals are allowed to function separately and they **must not** be wrapped together where they cross each other.

This type of brace will also be located at the hinge post side of a gate opening where the end brace assembly is anchoring the fence wire loads in one direction and supporting the weight of the gate in the other direction. The end brace assembly on the gate latch side will only be anchoring the fence wire loads and therefore require only one diagonal tension wire.

What are good construction methods and materials ?

The importance of proper construction of brace assemblies cannot be overstressed. Posts must be properly sized and must be driven into the ground to the full depth required (i.e. 3½ to 4 feet for most end posts). The driven posts must be in line with the fence as a small off-centre pull will tend to collapse the whole assembly. End or corner posts should lean away from the line of pull (up to 2 in from vertical).

As a rule-of-thumb for most fences, brace posts and rails are one diameter size larger than fence line posts. Fences that may have very heavy loading require brace posts two sizes larger (i.e. for confined areas such as pens or fences for large animals such as bison). The driven posts should be treated to resist rot but the brace rails do not normally require protection.

Standard high tensile steel wire is preferred for the brace wires as it has adequate strength. Two complete wraps are required. For fences with four strands or less, two wraps of a low tensile steel wire (such as most barbed wire) will suffice, but this brace wire will likely be a weak point. Fences that are expected to be 'tested' by livestock or windfalls should be constructed with superior braces. All brace wires should have Class 1 galvanization; Class 3 is preferred, especially in wet and coast locations.

Braces constructed with the 'drill & pin' method use steel rebar pins. Galvanized pins are unlikely required except in the very wettest environments.

Wooden brace 'twist sticks' should be a minimum 1.5 inch x 1.5 inch cross sectional size. They should be attached to the brace rail (a nail will do) to prevent accidental unwinding. If attached, the stick need not extend up past the brace rail and therefore will present no danger to livestock or wildlife that may attempt to jump the brace.

How to build a horizontal rail brace

While there are many possible brace designs, the horizontal rail brace is the most often used design. It provides the required strength in an easy to construct, economical layout.

This brace may be constructed as either a two-post brace (for normal soil and fence conditions), or a three-post brace (for poor soil or high fence load conditions). The two-post, horizontal rail is the standard brace for fences of 6 wires or less in suitable soils.

Construction steps for a two-post, horizontal rail, end brace

Two driven posts are connected by a rail and tensioned together by a brace wire. The rail-to-post connections are drilled (to prevent splitting) and pinned or nailed. Two diagonal wraps of 12 ½ ga high tensile smooth wire complete the brace giving it the required strength while maintaining flexibility under shock loads (such as falling trees).

Construction sequence is as follows (see Figure 2, page 3):

- drive the end post with a 2 inch lean away from the fence load
- drive the brace post spaced twice the fence height from the end post
- mark the drill holes on both posts at approximately $\frac{3}{4}$ fence height from the ground (i.e. 3 ft on a 4 ft fence)
- drill a $\frac{3}{8}$ inch diameter hole through each post in line with the fence
- cut the rail length to fit snug at this $\frac{3}{4}$ point
- drill a $\frac{3}{8}$ inch diameter hole 3 inches deep in the center at each end
- place the rail in position lining up the drilled holes
- drive a $\frac{3}{8}$ inch rebar pin through the posts and into each end of the rail
- leave 1 inch of pin protruding from the brace post; drive the pin flush in the end post
- drive a staple into the base of the end post about 4 inches from the ground
- hook one end of the brace wire onto the protruding brace post pin
- wrap two full turns around the staple and the pin
- pull all slack out of the brace wire
- hook the remaining end of brace wire around the pin
- staple off both ends of the brace wire
- twist the brace wire using a twist stick to remove the wire slack
- secure the twist stick to the rail (nail or wire on)
- attach the line wires

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