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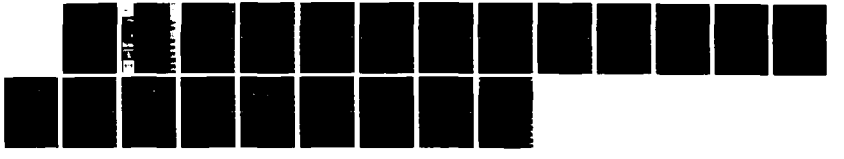

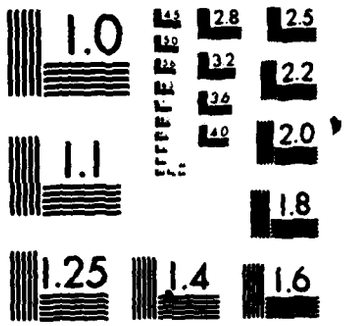

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SPECIAL WIRE FENCES

Section 5.2.2, US ARMY CORPS OF ENGINEERS WILDLIFE RESOURCES MANAGEMENT MANUAL

by

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19 ABSTRACT (Continue on reverse if necessary and identify by block number)

A management techniques report on special wire fences is provided as Section 5.2.2 of the US Army Corps of Engineers Wildlife Resources Management Manual. The report was prepared as a guide to assist Corps biologists and resource managers in the selection and implementation of special wire fence techniques where these fences are required or desirable for wildlife and habitat management programs. Topics covered include description, design and construction, placement, personnel and costs, and cautions and limitations.

Special wire fences are modifications of and alternatives to the conventional fence design. They are useful as interior division or cross-fences and are readily passable by wildlife, and some designs are also suitable as boundary fences. The types of special wire fences described in this report are the suspension fence, let-down fence, and high-tensile fence. Details are presented on the design, construction, installation, and maintenance of special wire fences. Specification drawings and lists of materials required are included.
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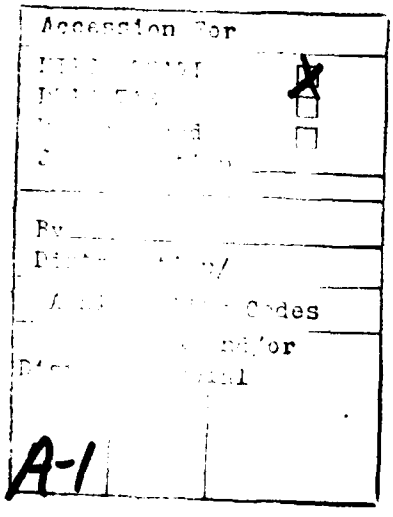
19. ABSTRACT (Continued).

Guidelines are provided for the proper placement of special wire fences in appropriate project settings.



PREFACE

This work was sponsored by the Office, Chief of Engineers (OCE), US Army, as part of the Environmental Impact Research Program (EIRP), Work Unit 31631, entitled Management of Corps Lands for Wildlife Resource Improvement. The Technical Monitors for the study were Dr. John Bushman and Mr. Earl Eiker, OCE, and Mr. Dave Mathis, Water Resources Support Center.

This report was prepared by Mr. Larry E. Marcy, Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, Tex. Mr. Marcy was employed by the Environmental Laboratory (EL), US Army Engineer Waterways Experiment Station (WES), under an Intergovernmental Personnel Act contract with Texas A&M University during the period this report was prepared. Mr. Chester O. Martin, Team Leader, Wildlife Resources Team, Wetlands and Terrestrial Habitat Group (WTHG), EL, was principal investigator for the work unit. Mr. Michael L. Hanson, Agri-Fence Co., Rough and Ready, Calif., provided guidelines and specifications for high-tensile fences. Review and comments were provided by Mr. Chester O. Martin and Dr. Wilma A. Mitchell, WTHG, Mr. Ted B. Doerr, Colorado State University, Fort Collins, Colo., and Mr. E. Paul Peloquin, US Army Engineer Division, North Pacific, Portland, Oregon.

The report was prepared under the general supervision of Dr. Hanley K. Smith, Chief, WTHG, EL; Dr. Conrad J. Kirby, Chief, Environmental Resources Division, EL; and Dr. John Harrison, Chief, EL. Dr. Roger T. Saucier, WES, was Program Manager, EIRP. The report was edited by Ms. Jessica S. Ruff of the WES Publications and Graphic Arts Division (PGAD). Drawings were prepared by Mr. John R. Harris, Scientific Illustrations Section, PGAD, under the supervision of Mr. Aubrey W. Stephens, Jr.

At the time of publication, COL Allen F. Grum, USA, was Director of WES, and Dr. Robert W. Whalin was Technical Director.

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NOTE TO READER

This report is designated as Section 5.2.2 in Chapter 5 -- MANAGEMENT PRACTICES AND TECHNIQUES, Part 5.2 -- FENCES AND CROSSINGS, of the US ARMY CORPS OF ENGINEERS WILDLIFE RESOURCES MANAGEMENT MANUAL. Each section of the manual is published as a separate Technical Report but is designed for use as a unit of the manual. For best retrieval, this report should be filed according to section number within Chapter 5.

SPECIAL WIRE FENCES

Section 5.2.2., US ARMY CORPS OF ENGINEERS
WILDLIFE RESOURCES MANAGEMENT MANUAL

Special wire fences are modifications of and alternatives to the conventional fence design. These fences are less costly, require fewer materials, are easier to construct, and are as effective in controlling livestock as a conventional wire fence. Modified fences vary in type of corner post construction, width between line posts, and type of fence wire used. The 3 types of special wire fences described herein are the (1) suspension fence, (2) let-down fence, and (3) high-tensile fence. Special wire fences are useful as interior division or cross-fences and are readily passable by wildlife. High-tensile fences are also suitable as boundary fences.

DESCRIPTION

Suspension Fence

A suspension fence is well adapted to flat or undulating terrain, is useful as an interior or cross-fence, is long lasting, requires less maintenance than the conventional fence, and works well with all grazing systems (Vallentine 1971). This type of fence gives and sways with animal contact; therefore, wire breakage and animal injury are minimal. Line posts are placed at 80- to 100-ft intervals rather than the 16- to 25-ft interval of a conventional wire fence. Therefore, approximately 200 fewer line posts per mile are required, reducing the expense in materials from one-half to two-thirds that of a conventional fence.

Let-down Fence

A let-down fence is used as interior or cross-fencing and is essentially the same as a conventional wire fence except that the wire strands are not permanently attached to line posts. Instead, the wire strands are stapled to wooden stays that are attached to the wooden line posts by wire loops. Thus, entire fence sections can be lowered or raised when needed. This type of fence is best used on flat to slightly rolling terrain. The USDA Forest Service (1972) recommends the use of a let-down fence (1) where fence damage from snow is severe, (2) in heavily timbered country, and (3) where any temporary fence is needed (e.g., to control livestock or visitor access on critical habitat or revegetated sites).

High-tensile Fence

An alternative to the barbed wire fence is the high-tensile or spring-steel smooth wire fence, which was developed in New Zealand and Australia in the early 1960's (Hanson 1982; Jepson et al., undated). The basic design and construction methods are similar to those described for conventional fences, except that (1) smooth, high-tensile strength wire is substituted for barbed wire; (2) all corner posts, brace posts, and line braces need to be made with high-quality posts to withstand the increased stress of high-tension wire; (3) permanent in-line wire stretchers are used on each strand to maintain proper tension; and (4) the distance between line posts is greater. Fewer posts and stays are required because the high tension (200 to 300 lb) helps maintain wire spacing. In-line wire strainers and tension springs enable wire tension to be easily regulated (i.e., to either tighten the fence or release tension in heavy snowpack or as temperature varies). When wires are displaced by trees, snow, livestock, wildlife, or other factors, the entire section of fence can be tightened in minutes. Wire strands can also be easily spliced with the aid of a figure-8 knot or crimping sleeves.

DESIGN AND CONSTRUCTION

Suspension Fence

Construction methods for a suspension fence are the same as described for conventional fencing, except that corner and brace post installation must be stronger and special metal clips are used to attach wire strands to the posts

(Fig. 1). Fewer line posts are used; therefore, more weight of the wire must be supported by corner and brace posts and widely spaced line posts. Two line posts, 80 to 120 ft apart, replace every 4 to 5 line posts used in a conventional fence. Corner and brace post installation is shown in Figure 2. Each corner should be securely anchored with a "deadman" set at least 4 ft deep. Materials for constructing 1 mile of 4-strand suspension fence are listed in Table 1.

Wire is strung and attached to corner posts as done for a conventional fence. Each strand should have no more than a 3-in. sag per strand. Nail-on clips are used to attach wire strands to the posts because standard staples will not hold the weight of the wire in this type of installation. Stays may be made of wood, wire, or fiberglass, and they should not touch the ground after installation as this would interfere with the fence moving on contact.

Let-down Fence

Let-down fence construction differs from a conventional fence in that a let-down fence must be able to be lowered when not needed or when weather conditions are such that the fence will be damaged if erect. Corner, brace, and line posts are installed following guidelines presented for a conventional fence.

Proper wire attachment is critical to construction of a let-down fence (Fig. 3). Wood stays, 2 × 2 × 48 in., are attached to each post with 9-1/2-ga wire loops. The top loop should lift off easily over the wooden stay. The bottom loop should be tight enough to hold the stay firmly but must allow the stay to lie on the ground when necessary. Wire loops should be stapled to the back of the line post. In addition, the bottom wire loop should be stapled to the stay. An alternative to stapling the bottom wire loop to the stay is to drill an 1/8-in.-diam hole through the stay; the loop wire is passed through the hole, and the ends of the wire are twist-tied together and stapled to the back side of the line post. Wire strands are tied off to the stay attached to the corner post and strung to the next corner or line brace, depending on the length of the span. Wire strands are not stretched but are pulled as straight as possible by hand and tied off. After all wires have been strung, each strand is stapled or clipped to the stays at the correct height. Wire stays should be used between each wooden stay to help separate the wire strands.

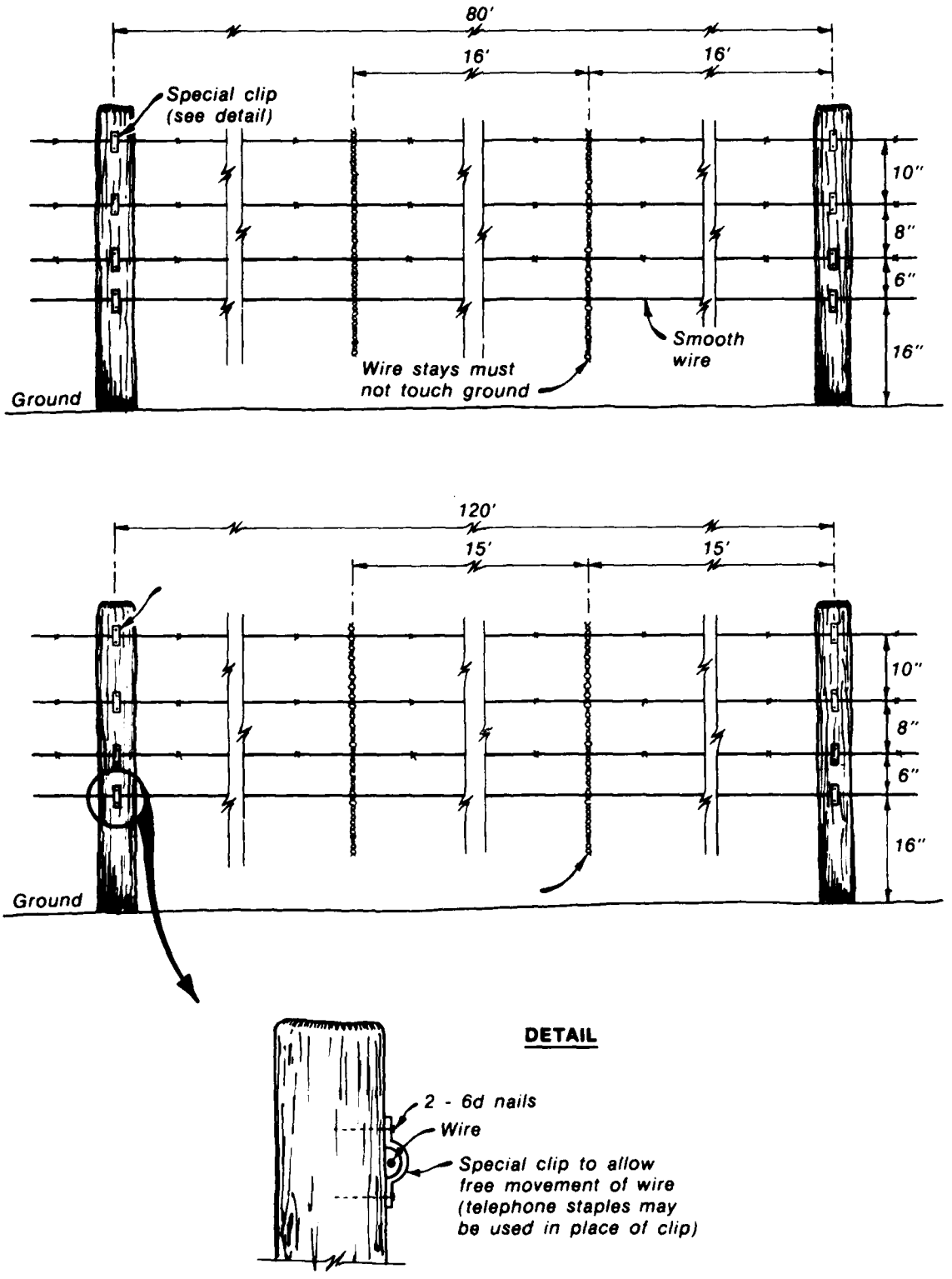


Figure 1. Fence post placement and wire spacing for 80-ft- and 120-ft-span suspension fences, and detail showing metal clips used to attach wire strands to posts (adapted from USDA Forest Service 1972)

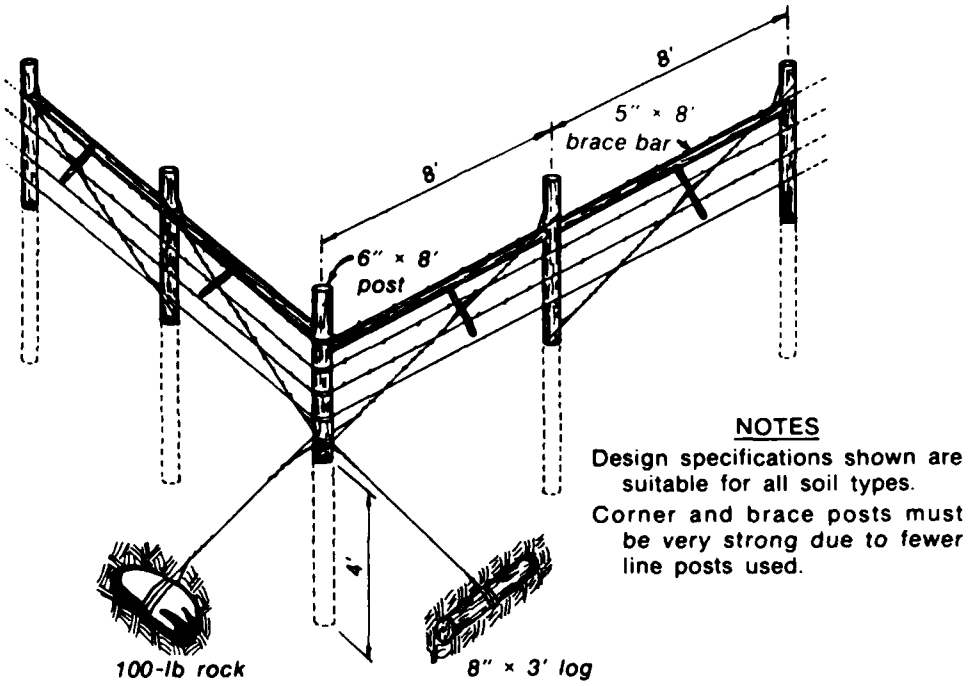


Figure 2. Suspension fence corner and brace post installation (adapted from USDA Forest Service 1972)

The fence should be lowered and raised several times during construction to make adjustments in wire loops. Materials necessary to construct 1 mile of 4-wire let-down fence are listed in Table 2.

High-tensile Fence

Construction details presented here for the high-tensile fence are largely those provided by Hanson (1982); the design requires fewer posts, costs less, and is as strong or stronger than the conventional wire fence system. Corner posts should be at least 6 in. in diameter, 8 ft long, and set 4 ft in the ground. Figure 4 shows typical corner post construction. Materials required to build 1 mile of high tensile fence are listed in Table 3.

The following procedures for constructing and installing a high-tensile fence were recommended by Hanson (1982):

(1) Set all corner posts and brace bars, then string the second from the bottom wire. Stretch this wire only tight enough to remove slack; it will serve as a straight line on which to set the remainder of the line posts and corner posts. Wire should be strung on the outside edge of all angles. All corner, angle, rise, and dip posts

Table 1. Materials for 1 mile of 40-in.-tall, 4-wire suspension fence with 1 wire gate, 1 corner, and line braces every 1/4 mile (from USDA Forest Service 1972)

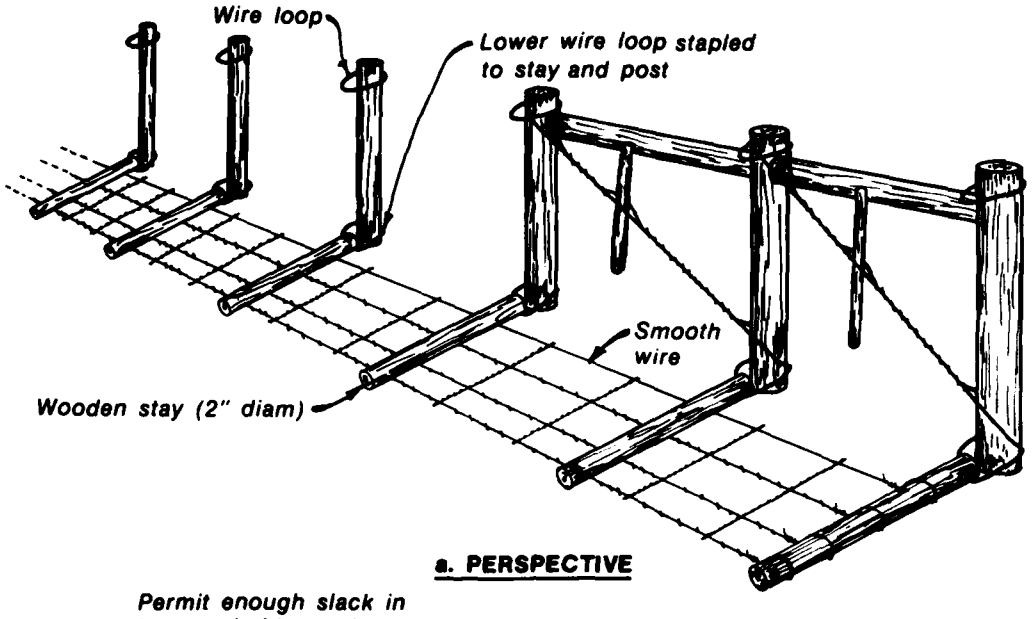
Item	Use	Quantity
Posts (wooden)		
6-in. diam × 9 ft	Corner post and line brace	15
5-in. diam × 8 ft	Horizontal brace bar	9
Posts (steel)		
6-ft-long T-post	Line post (spaced 100 ft apart)	52
Wire (galvanized)		
Barbed, 12-1/2-ga, 80-rod roll	Top 3 strands	12
Smooth, 12-1/2-ga, 80-rod roll	Bottom strand	4
Smooth, 9-1/2-ga, 500-ft roll	Bracing	1
Stays (twisted wire)		
38 in. long, 9-1/2-ga	Maintain wire spacing	320
Staples		
1-1/2 in. long	Secure wire to posts	10 lb
Clips (metal)		
nail-on clip	Attach wire to posts	30
Nails		
6d	Attach clips	2 lb

should be footed (refer to Section 5.2.1, Conventional Wire Fences).

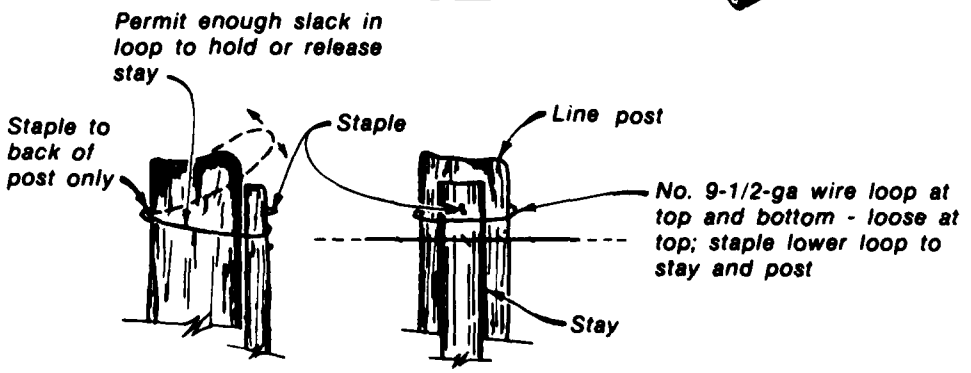
(2) The first step in setting the brace bar for the corner post is to trim one end of the brace bar, as shown in Figure 4. After trimming the bar, hold the trimmed end of the brace in the middle of the corner post and mark the outline of the trimmed end on the post approximately 24 in. above the ground. Keep the other end of the brace bar on the ground. Make sure the brace bar is on an accurate line with the wire strand.

(3) Chisel out the outlined portion on the corner post approximately 5/8 to 1 in. deep. When the fit of the brace bar into the corner post is completed, mark where the untrimmed end of the brace bar touches the ground. This mark is the location of the far edge of the brace block.

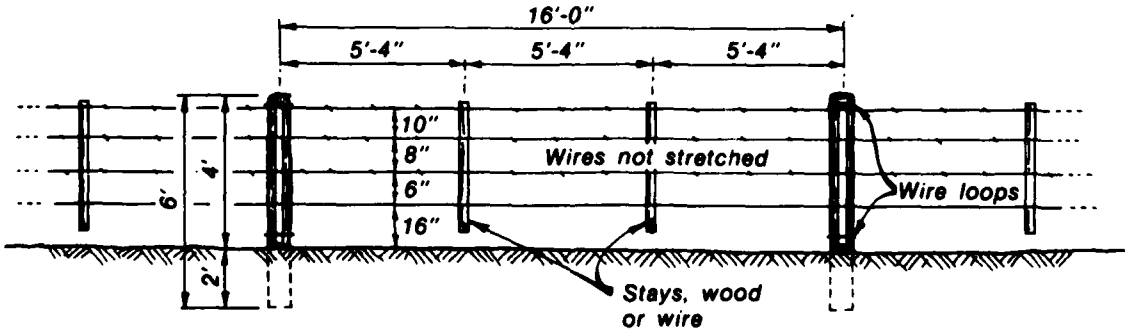
(4) Dig a trench perpendicular to the wire strand and toward the corner post from the mark on the ground. The bottom of the trench should be angled upward toward the corner post and deep enough to bury the brace block.



a. PERSPECTIVE



b. DETAIL OF FASTENER



c. SPACING DETAILS

Figure 3. Design specifications for a let-down fence, showing (a) perspective view of fence in let-down position, (b) fastener detail, and (c) proper spacing of posts and wires (adapted from USDA Forest Service 1972)

Table 2. Materials for 1 mile of 4-wire let-down fence with 1 wire gate, 1 corner post, and line braces every 1/4 mile (from USDA Forest Service 1972)

Item	Use	Quantity
WOODEN FENCE		
Posts		
6-in. diam × 9 ft long	Corner and brace posts	21
5-in. diam × 8 ft long	Horizontal braces	7
4-in. diam × 6 ft long	Line posts	255
Wire (galvanized)		
Barbed, 12-1/2-ga, 80-rod roll	Top 3 strands	12
Smooth, 12-1/2-ga, 80-rod roll	Bottom strand	4
Smooth, 9-1/2-ga, 80-rod roll	Loops	1
Stays		
Wooden, 4-in. diam × 4 ft long	Secure fence to corner and brace posts	9
Wooden, 2-in. diam × 4 ft long	Secure fence to line posts	255
Wire, 9-1/2-ga, 42 in. long	Maintain wire spacing	525
Staples (galvanized)		
1-1/2 in. long	Secure wire to stays	90 lb
Nails		
40d	Secure brace posts	4 lb
Nico-Press Sleeves (optional)		
0.148-in. diam	Wire splice	265
WOODEN AND STEEL FENCE		
Posts (wooden)		
6-in. diam × 9 ft long	Corner and brace posts	21
5-in. diam × 8 ft long	Horizontal brace post	7
4-in. diam × 6 ft long	Line posts	49
Posts (steel)		
6-ft-long T-post	Line posts	206
Staples (galvanized)		
1-1/2 in. long	Secure wire to posts	50 lb
All other items the same as for the wooden let-down fence.		

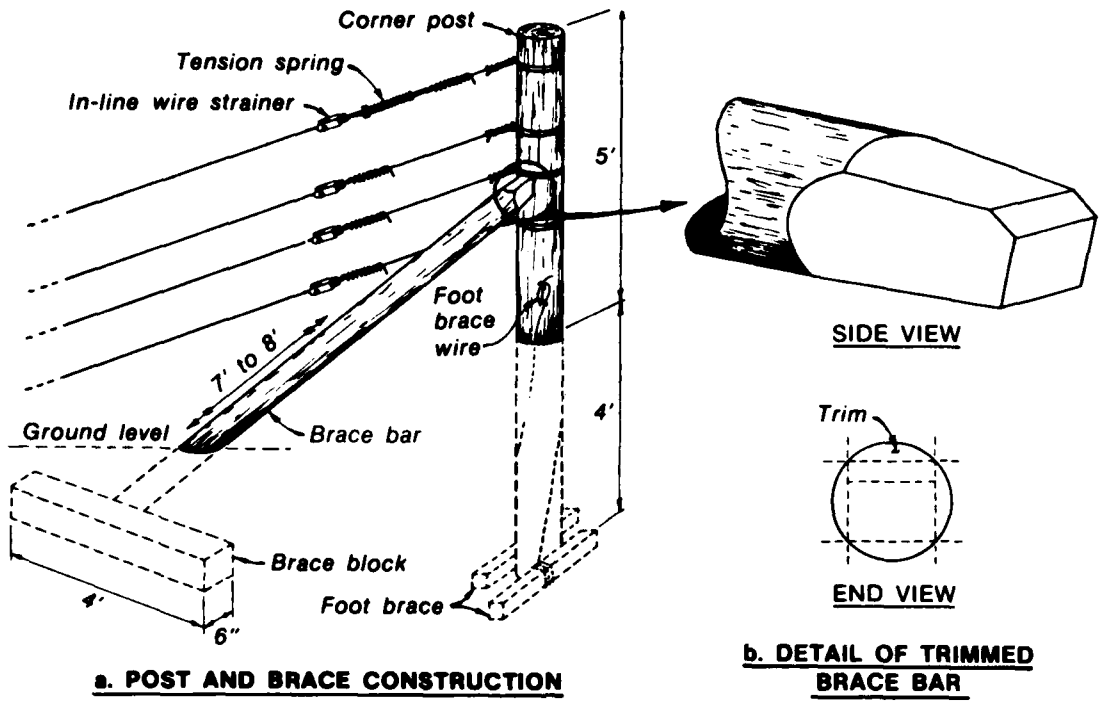


Figure 4. Corner post construction of a high-tensile fence (a), showing trimmed end of brace bar (b) (from Hanson 1982)

(5) Brace blocks should be made of pressure-treated wood at least 4 ft long and 6 in. in diameter. Place the brace block in the trench and dig a shallow channel approximately 4 ft long from the center of the brace block trench toward the corner post to accommodate the end of the brace bar.

(6) Position the trimmed end of the brace bar in the corner post notch and center the other end on top of the brace block. For proper alignment, the outside edge of the brace bar should touch the wire strand.

(7) Trim the end of the brace bar 1 in. longer than necessary to fit between the brace block and corner post. Force the brace bar down onto the face of the brace block and cover the block with soil. All fence angles and line braces should be braced as done for corner posts.

(8) String the second wire from the top and tie it off. With 2 wires strung, line, rise, and dip posts can be accurately placed. Line posts can be wooden, metal, or fiberglass and can be spaced 20 to 60 ft apart. Rise and dip posts should be wooden.

(9) After all posts are set, string the top wire and tie it off, but leave some slack in the wire. Cut the wire in the center of the strand or near one end and tie in a permanent wire stretcher and tension spring. Crank up the tension on the wire with a tension or

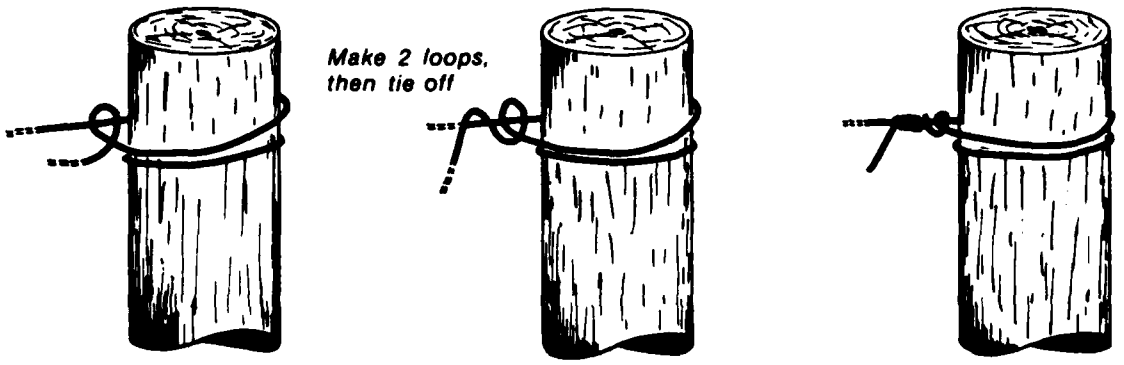
Table 3. Materials required to build 1 mile of 4-wire high-tensile fence on level ground with 40 ft between line posts

Item	Use	Quantity
Posts (wood)		
6-in. diam × 9-ft long	Corner posts and line braces	5
4-in. diam × 8-ft long	Brace bars	5
6-in. diam × 4-ft long	Brace blocks	5
Posts (metal or fiberglass)		
6-ft T-post	Line posts	132
Wire (high tensile)		
12-1/2-ga, smooth	Fence strands	540 lb
Staples (galvanized)		
1-1/2 in. long	Secure fence wire to posts	4 lb
Wire clips		
Nail-on type	Secure fence wire to T-posts	530
Permanent wire strainers		
1-7/8 × 3-3/4 in.	Stretch wire	8
Nico-sleeves (optional)		
For 12-1/2-ga high-tensile wire	Splice wire	12

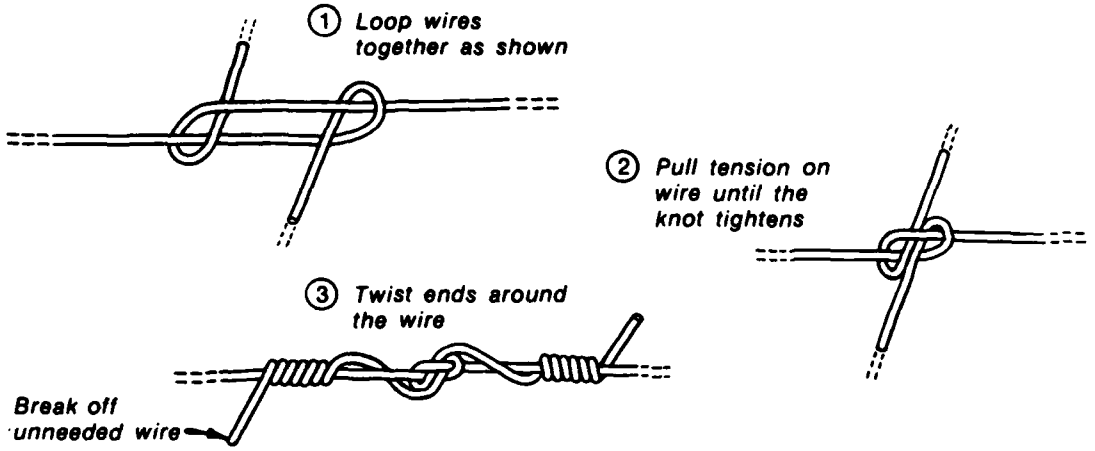
ratchet handle to 200 to 300 lb. Wire tension can be determined using a spring-scale or permanent in-line indicator spring (see Section 5.2.1, Conventional Wire Fences). Wire tension depends on the wire manufacturer's recommendations.

(10) Continue the process of tying in wire stretchers and tensioning the wires. Staple wires to the post as described for conventional fences. The staple should be driven so as not to crimp or bind the wire strand. Placing another staple behind the wire and over the driven staple is recommended to prevent the wire from digging into the post.

Hansen (1982) found that the most efficient knot for splicing high-tensile wire is the figure-8 knot, which maintains approximately 76% of the wire strength (Fig. 5). Once the knot is tied, pull tension on the wires until the knot tightens, then wrap the tails around the wire 6 times and break off the excess. Mechanical fasteners such as crimping sleeves, wire anchors, and other wire fasteners are better than knots (Selders et al. 1981). They provide a quick, efficient method of splicing and fastening, and if properly installed, do not slip or weaken the wire.



a. HALF-HITCH TIE-OFF



b. FIGURE-8 SPLICING KNOT

Figure 5. Half-hitch tie-off for high-tensile wire (a), and figure-8 knot used for splicing high-tensile wire (b)

PLACEMENT

The special wire fences discussed above can be used satisfactorily as a substitute for conventional interior division and cross-fences. The high-tensile fence is also appropriate for all boundary fences. Fence placement follows the guidelines outlined under Section 5.2.1, Conventional Wire Fences. Let-down fences are recommended where snow buildup is a problem (Vallentine 1971).

PERSONNEL AND COSTS

A comparison of costs and maintenance between special wire and conventional fences is provided in Section 5.2.1. Suspension fence construction time is approximately one-half to two-thirds that of a conventional fence (Ragsdale 1975). Construction time for a 3- or 4-strand suspension fence requires approximately 50 man-hours/mile (Moore et al. 1968). However, soil conditions can affect construction time. Ragsdale (1975) found that on dry, hard, and rocky soils, 108 man-hours of labor/mile were required to build a suspension fence with 80 ft between line posts. Labor requirements for let-down fences are greatest of all fence designs discussed (Jepson, et al. undated). Lokemoen et al. (1982) estimate labor costs for high-tensile fences to be $0.08 to $0.12/ft or approximately $435 to $635/mile on level and rolling terrain, respectively. Approximately 30 man-hours are required to build 1 mile of 4-strand high-tensile fence (Mike Hanson, Agric-Fence Co., Rough and Ready, California, pers. commun., 1983). Yearly maintenance takes approximately 10 man-hours/mile.

CAUTIONS AND LIMITATIONS

Precautionary guidelines discussed under Conventional Wire Fences should be followed for special wire fences. Suspension and let-down fencing should be used only on level to gently rolling terrain. Suspension fencing is not recommended for use in heavy-snow country. The use of let-down fences is limited for the following reasons: (1) they provide no protection against trespass when lowered; (2) they must periodically be raised or lowered, resulting in higher labor costs; (3) wire strands rust when in contact with the ground for several months; and (4) initial construction costs are higher than a conventional wire fence. However, construction costs can often be justified compared to maintaining a conventional fence in heavy-snow country (Vallentine 1971).

Proper wire tension is the key to achieving best results with the high-tensile fence. Seasonal temperature changes cause substantial expansion and contraction of the wire (Selders et al. 1981); thus, the tension should be adjusted twice a year. In late October the wire tension should be set from 200 to 225 lb, and in early May it should be reset from 250 to 275 lb. Fence lines must not be burned to clear vegetation from fences because the

wire will become brittle and subject to breakage (Hanson, pers. commun., 1983). Precautions for the use of wood preservatives are discussed in Section 5.2.1.

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