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**SIGNIFICANT TIME AND COST SAVINGS
RESULT FROM THE USE OF
MODULAR STEEL BRIDGE SYSTEMS**

BOUNDARIES

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**FOREST SERVICE
U.S. DEPARTMENT OF AGRICULTURE
Washington, D.C. 20013**

SIGNIFICANT TIME AND COST SAVINGS RESULT FROM THE USE OF
MODULAR STEEL BRIDGE SYSTEMS*

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INTRODUCTION

Systems bridge construction has been defined as on-site assembly of modular bridge components that are mass produced to standard dimensions at an off-site plant. Systems techniques have been used successfully in other industries to reduce costs by improving production efficiency (Reference 1). Application of modular systems construction techniques to bridge construction in Alaska's remote areas has resulted in significant time and cost savings.

For many years, the blast rock-decked native log stringer bridge has been the mainstay bridging system for logging roads in southeast Alaska (figure 1). Until recently, this system was used almost exclusively, due primarily to the speed of construction (1 to 2 days) and to the abundance of large, high-quality Sitka spruce logs available near the bridge sites. This is probably the simplest "systems technique" available. Bridge construction from these native materials has been very economical. Installation cost allowances to loggers for constructing this type of bridge have ranged from \$50 to \$110 per linear foot (per 0.3 meter), which converts to \$3 to \$7 per square foot (per 0.09 square meter) (Reference 2).

However, the rising market value of the high-quality spruce used for bridge stringers has made it desirable to look for other solutions for bridging streams.

About 1.5 million board feet (3,540 cubic meters) of prime logs have been used each year for log stringer bridges in southeast Alaska. At an estimated present export value of \$1,700/MBM for select prime spruce, this represents the equivalent of more than \$2.5 million worth of timber (Reference 2).

This paper describes modular, portable, reusable bridge systems as alternatives to native log stringer bridges or conventionally

**This is a follow-up report to the article entitled "Portable Bridges for Use on Logging Roads," Field Notes, Vol. 10, No 12, December 1978.*

constructed-in-place permanent bridges. A previous article, "Portable Bridges for Use on Logging Roads" (Field Notes, Vol. 10, No. 12, December 1978), described the Region 10 road system and the criteria used to select portable modular bridge systems. The following paragraphs describe the two types that were selected.



Figure 1.--Typical log stringer bridge.

HAMILTON CONSTRUCTION COMPANY "E-Z" BRIDGES (Reference 3)

The Hamilton Construction Company of Springfield, Oregon, has patented a single-lane prebuilt modular steel bridge superstructure, called the "E-Z" Bridge, which is suitable for permanent or temporary use on single-lane roads.

Installation is rapid, without the usual lag time for on-site construction of the superstructure, and the bridge can be moved and reused easily. The bridge consists of steel girders with a treated

timber deck, split longitudinally into two sections, with each section carrying one wheel line (figure 2). The two sections are connected to one another by hinged, bolted diaphragms; they are rigged to be handled and loaded with standard logging equipment and hauled on standard logging trucks without modification (figure 3). The bridges have been designed for standard HS20-44 or for USDA-FS 80- and 100-ton (72.5- and 90.7-metric ton) truck loading with impact and 90-ton (81.6-metric ton) log loader loading without impact and are available in either ASTM A-36 painted steel or ASTM A-588 (Cor-Ten) weathering steel, which averages about 16 percent higher in price. For durability and corrosion resistance in the wet southeast Alaska climate, the 16-percent additional cost will add many years to the useful life of the structure.

These structures can be furnished in either 14- or 16-foot (4.27- or 4.88-meter) widths. The 16-foot (4.88-meter) width has been adopted for Alaskan use to accommodate the logging equipment that must use the bridges.

The AASHTO requirement limiting deflection to 1/800 of the span length was deemed too restrictive. This requirement was reduced to 1/300 of the span length, resulting in nearly 50 percent savings in the weight of required structural steel, as shown in table 1.

After the abutments are installed, the complete superstructure can be installed and made ready for traffic in a matter of hours. It is not unusual for traffic to be using the bridge within 2 hours after the sections arrive at the site.

TABLE 1.--ROLLED BEAM SIZE FOR U-80 LOADING--16-FOOT (4.88-METER) DECK ALASKA FOREST SERVICE, A-588 STEEL.

Span Length (ft)	L/300	L/800
30 (9.14 m)	W 24 in. x 61 lb (0.61 m x 27.67 kg)	W 24 in. x 84 lb (0.61 m x 38.10 kg)
40 (12.19 m)	W 24 in. x 76 lb (0.61 m x 34.47 kg)	W 30 in. x 108 lb (0.76 m x 48.99 kg)
50 (15.24 m)	W 27 in. x 94 lb (0.69 m x 42.64 kg)	W 36 in. x 150 lb (0.91 m x 68.04 kg)
60 (18.29 m)	W 30 in. x 116 lb (0.76 m x 52.62 kg)	W 36 in. x 230 lb (0.91 m x 104.33 kg)

NOTE: L = Length
W = Wide-flanged beam

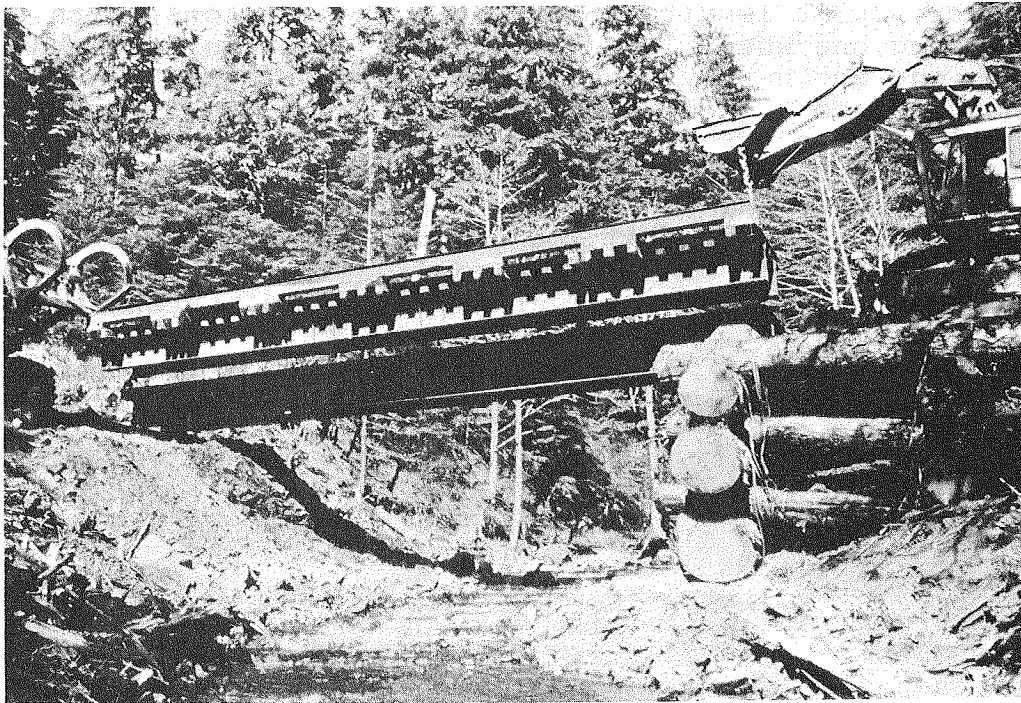


Figure 2.--Hamilton "E-Z" Bridge being installed on temporary log crib abutments with normal logging equipment; one half already in place and the second half being lowered into place.

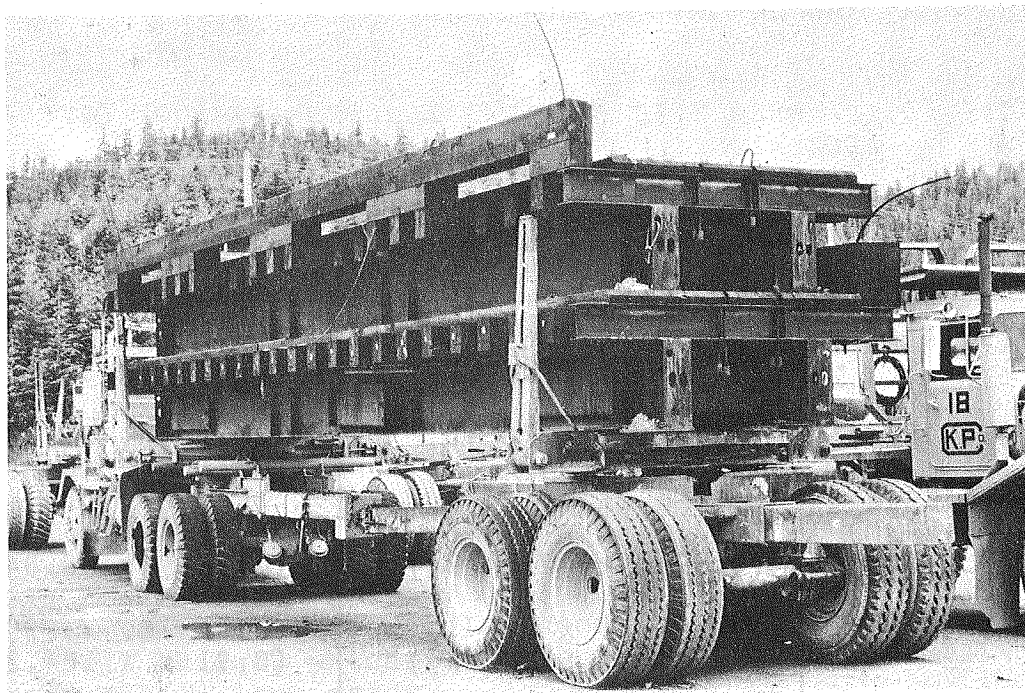


Figure 3.-- Hamilton "E-Z" Bridge, ready to be transported to the bridge site.

ACROW PANEL BRIDGES (BAILEY TYPE) (Reference 4)

The Acrow Panel Bridge is the modern version of the famous World War II Bailey Bridge. Nearly 40 years of constant development have gone into this system concept.

This bridge system's greatest asset is its extreme versatility. Speed of erection and economy, particularly where the bridge will be reused, are also important factors.

The cantilever launching method is of particular interest if it is important to avoid stream disturbance. Using the cantilever method, any length bridge can be constructed on one bank and launched over rollers (without the need for heavy lifting equipment) using a false nose that is later removed. (See pages 10 and 11, Field Notes, Vol. 10, No. 12, December 1978, for pictures.)

The main girders are composed of identical 5- by 10-foot (1.52- by 3.05-meter) Acrow Panels pinned together end-to-end and, where necessary for greater load-carrying capacity, connected side-to-side and in multiple stories to form continuous girders from abutment to abutment on either side of the bridge decking (figures 4 and 5). Various widths, as listed in table 2, are available simply by using floor beams (transoms) of different lengths and deck units of different widths. Timber or steel plate decks can be used.

For Alaska Region use, the Ultra-wide structure is required to provide adequate width for yarding equipment; however, the extra-wide configuration can be considered when the additional width is not needed. By purchasing double-wide transoms, bracing, and additional decking units, double-lane bridges can be constructed with the same components.

TABLE 2.--ACROW PANEL BRIDGE WIDTHS

Description	Roadway Width	Clearance Between Trusses
Standard	11 ft 3 in. (3.43 m)	12 ft 4 in. (3.76 m)
Extra Wide	13 ft 6 3/4 in. (4.13 m)	15 ft 8 in. (4.78 m)
Ultra Wide	15 ft 10 1/2 in. (4.84 m)	17 ft 11 3/4 in. (5.4 m)
Double Wide	23 ft 8 1/2 in. (7.23 m)	24 ft 11 in. (7.60 m)

Acrow Panels can be used vertically to form piers and towers. In addition, the components can be used for falsework or other applications where temporary heavy support is required.

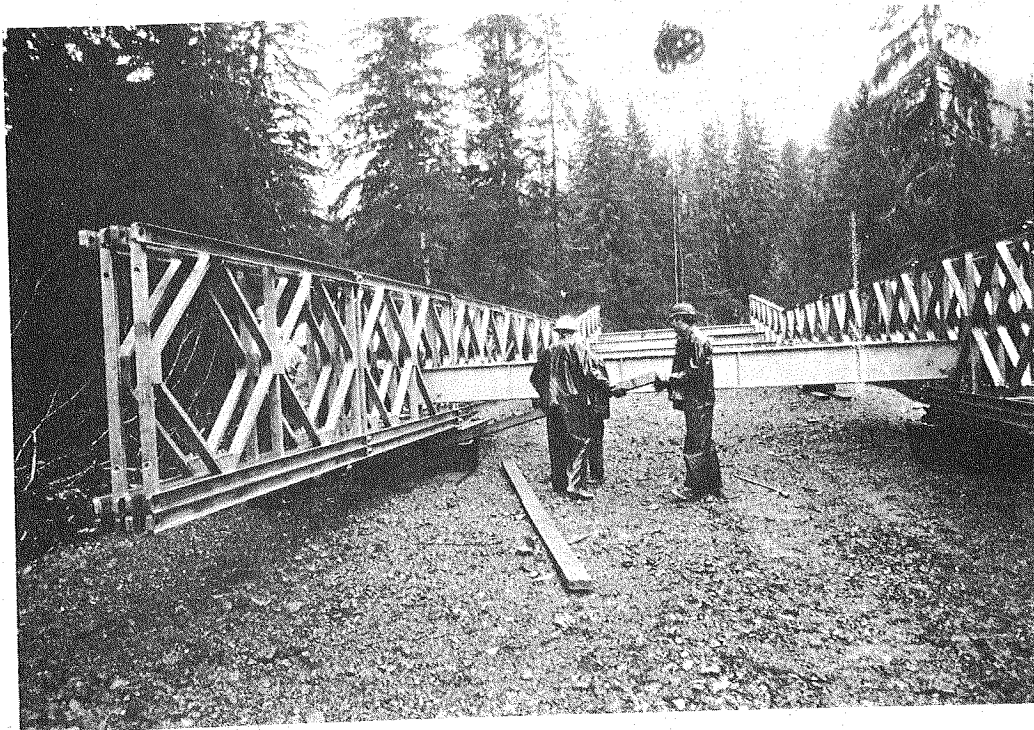


Figure 4.--Acrow Panel Bridge being assembled on rollers for launching.

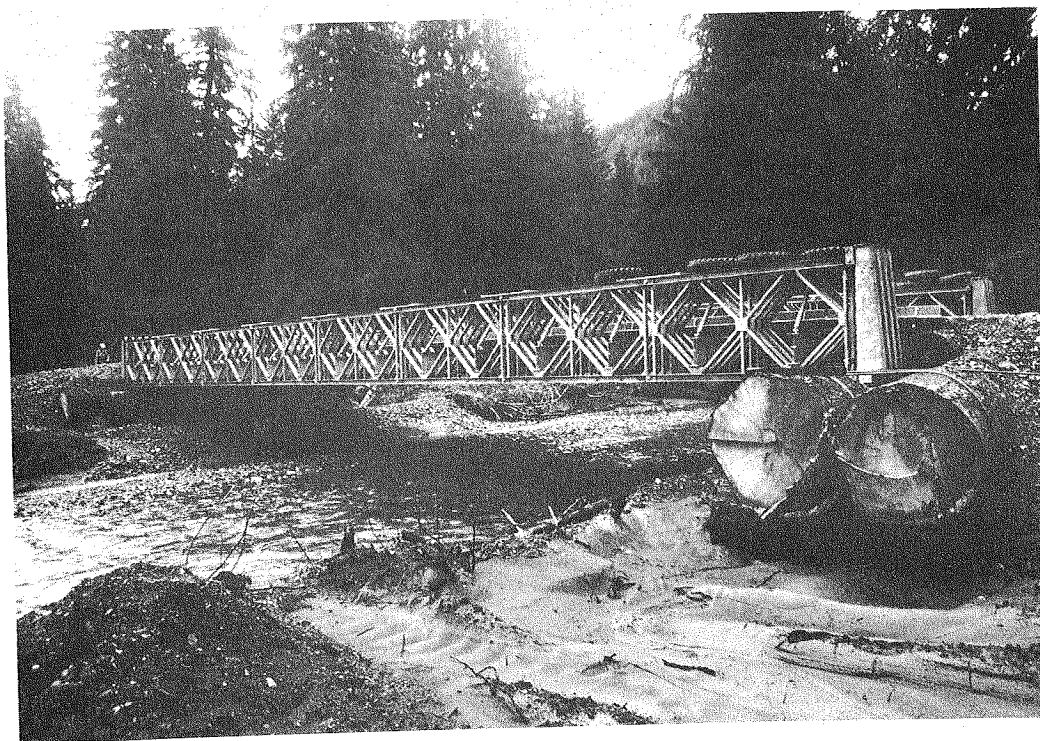


Figure 5.--Completed 80-foot (24.38-meter) Acrow Panel Bridge on temporary log sill abutments.

As with the Hamilton "E-Z" Bridges, durability and corrosion-resistance are important. The Acrow components are not available in weathering steel; however, they can be hot-dip galvanized to increase corrosion resistance to approximately quadruple the normal useful life, at about an 18-percent increase in cost. All Acrow Panel Bridges in Region 10 have been galvanized.

Single-story Acrow Panel Bridges can normally be assembled, launched, and completed in less than 1 week.

USE IN THE ALASKA REGION

In March and April 1977, contracts were awarded to Hamilton Construction Company to furnish ten Hamilton "E-Z" Bridges and to Acrow Corporation of America to furnish seven Acrow Panel Bridges and two launching noses. These bridges were delivered to Seattle for transshipment to Alaska. Modifications were made to existing long-term (50-year) timber sale contracts held by Alaska Lumber and Pulp Company (ALP) and by Louisiana Pacific-Ketchikan Division (LPK), to: (1) transport the bridges by barge from Seattle to each bridge site, (2) install the bridges on log crib abutments, (3) remove and transport to a storage area or to a new site, and (4) reinstall the bridges. These 17 bridges were subsequently barged to Alaska and installed.

In May 1978, a 190-foot (57.91-meter) span Acrow Panel Bridge with permanent abutments was added to the ALP long-term sale, and in September 1978, a 100-foot (30.48-meter) Acrow Panel Bridge was added to the LPK long-term sale to replace a deteriorating native log stringer bridge. In September 1978, a cooperative agreement was signed with ALP which provided for them to purchase and install 14 more Hamilton "E-Z" Bridges. Table 3 summarizes the use of modular steel bridges in the Alaska Region to date.

HAMILTON CREEK BRIDGE

Construction of the Hamilton Creek Bridge (figure 6) was noteworthy in several respects. At 190-foot (57.91-meter) clear span, it is the longest and heaviest Acrow Panel Bridge ever launched in North America. It is designed to carry the USDA Forest Service 80-ton and 100-ton truck loading as well as a 90-ton tracked log loader.

Both types of modular steel bridges were used for this project. Three Hamilton "E-Z" Bridges, two at 60 feet (18.29 meters) and one at 40 feet (12.19 meters), were installed end-to-end as a temporary construction access bridge (figure 7). They were installed in 1 1/2 days.

The 190-foot (57.91-meter) span double-quadruple reinforced Acrow Panel Bridge was constructed, launched, and lowered onto unique

TABLE 3.--MODULAR STEEL BRIDGE USAGE

Bridge Type	Length (Linear feet ea.)	Number	Total Materials Cost (FOB Seattle)	Total Installed Cost (Estimate)
			Dollars	Dollars
Hamilton "E-Z"	30 (9.14 m)	5	65,300	84,300
Hamilton "E-Z"	40 (12.19 m)	7	120,700	156,100
Hamilton "E-Z"	50 (15.24 m)	4	84,000	109,200
Hamilton "E-Z"	60 (18.29 m)	4	115,000	145,300
Hamilton "E-Z"	70 (21.34 m)	1	49,500	58,400
Hamilton "E-Z"	80 (24.38 m)	3	180,300	210,900
	<u>1,180 (359.66 m)</u>	<u>24</u>	<u>614,800</u>	<u>764,200</u>
			= 521.02/1 ft (1,709.38/m)	= 647.63/1 ft (2,124.77/m)
			32.56/sq ft (350.47/m ²)	40.48/sq ft (435.72/m ²)
Acrow Panel (Single Story)	50 (15.24 m)	1	29,000	35,400
Acrow Panel	70 (21.34 m)	2	95,000	112,900
Acrow Panel	80 (24.38 m)	1	54,000	64,200
Acrow Panel	90 (27.43 m)	1	74,000	85,500

Acrow Panel	$\frac{100 \text{ (30.48 m)}}{760 \text{ (231.65 m)}}$	$\frac{4}{9}$	$\frac{356,400}{608,400}$ $= 800.53/1 \text{ ft}$ $(2,626.41/\text{m})$ $50.03/\text{sq ft}$ $(538.52/\text{m}^2)$	$\frac{403,500}{701,500}$ $= 923.03/1 \text{ ft}$ $(3,028.31/\text{m})$ $57.69/\text{sq ft}$ $(620.97/\text{m}^2)$
Acrow Panel (Double Story)	190 (57.91 m)	1	$\frac{452,000}{2,378.95/1 \text{ ft}}$ $(7,804.94/\text{m})$ $148.68/\text{sq ft}$ $(1,600.38/\text{m}^2)$	$\frac{523,000}{2,752.63/1 \text{ ft}}$ $(9,030.72/\text{m})$ $172.04/\text{sq ft}$ $(1,851.82/\text{m}^2)$
Average All Types	2,130 (649.22 m)	34	$\frac{1,675,200}{786.48/1 \text{ ft}}$ $(2,580.31/\text{m})$ $49.15/\text{sq ft}$ $(529.05/\text{m}^2)$	$\frac{1,988,700}{833.66/1 \text{ ft}}$ $(2,735.10/\text{m})$ $58.35/\text{sq ft}$ $(628.07/\text{m}^2)$



Figure 6.--Hamilton Creek Bridge--190-foot (57.91-meter) span Acrow Panel Bridge (quadruple-double reinforced construction).



Figure 7.--Three Hamilton "E-Z" Bridges installed end-to-end as a temporary crossing during construction of the Hamilton Creek 190-foot (57.91-meter) Acrow Panel Bridge.

pile-supported fabricated steel abutments, which were designed by Charles Pool and Associates, Ketchikan (figures 8, 9, 10, 11, and 12). Including construction of the permanent abutments, the entire job took less than a month.

The launching illustrated the versatility of the Acrow System. Components of a 100-foot (30.48-meter) Acrow Panel Bridge that was scheduled to be installed several hundred miles away on the LPK long-term sale were first shipped to the Hamilton Creek site on the ALP long-term sale, assembled into a launching nose, used to launch the 190-foot (57.91-meter) Acrow Panel Bridge, disassembled, and shipped on to its ultimate destination on Prince of Wales Island. A significant saving in shipping costs resulted because it was unnecessary to furnish launching nose components and return them to Acrow.

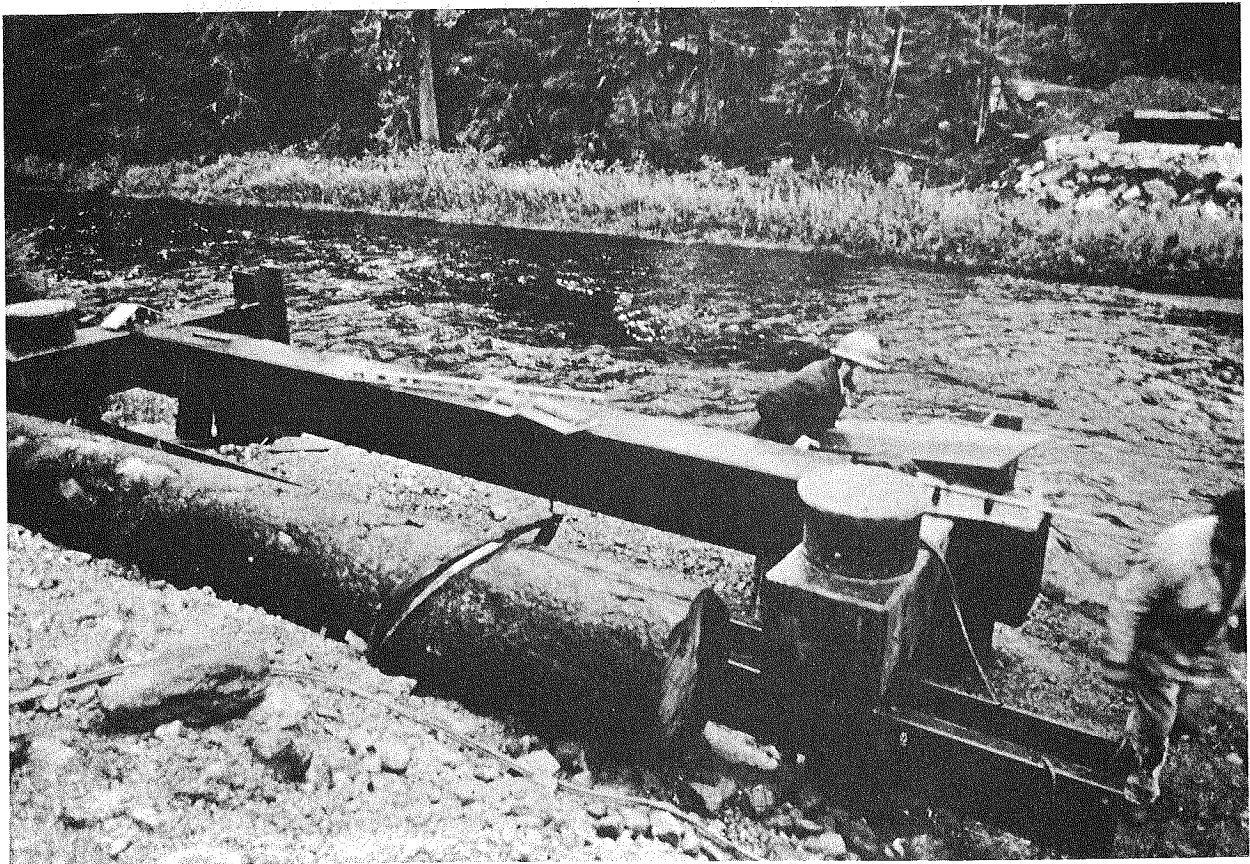


Figure 8.--H-pile supported steel abutments for the Hamilton Creek Acrow Panel Bridge.

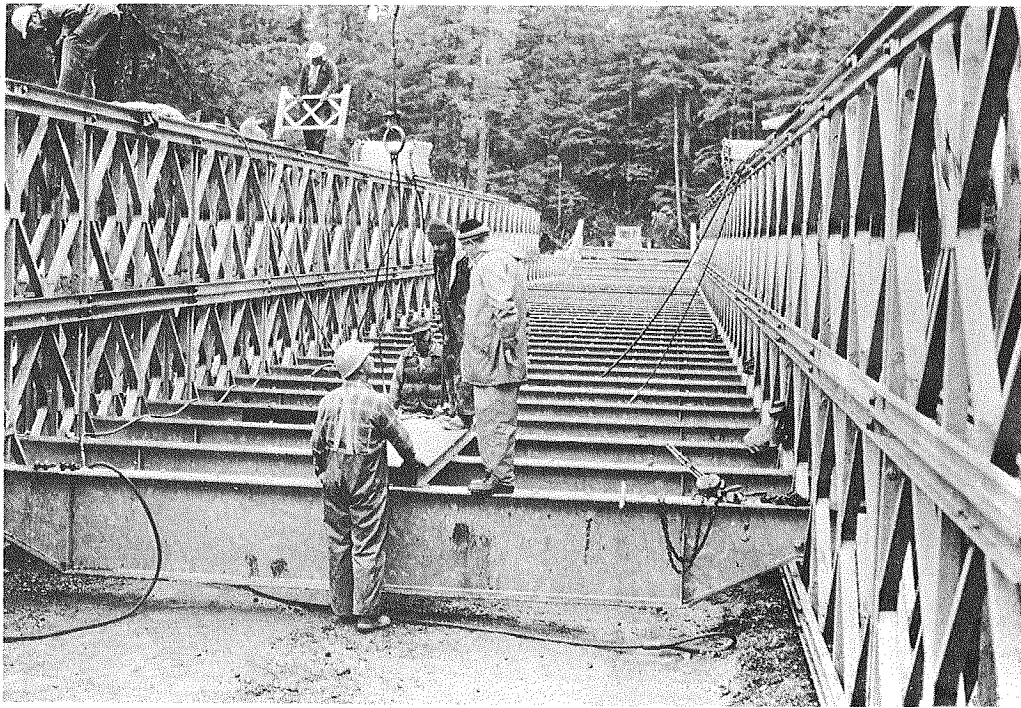


Figure 9.--Assembly of 190-foot (57.91-meter) Acrow Panel Bridge.

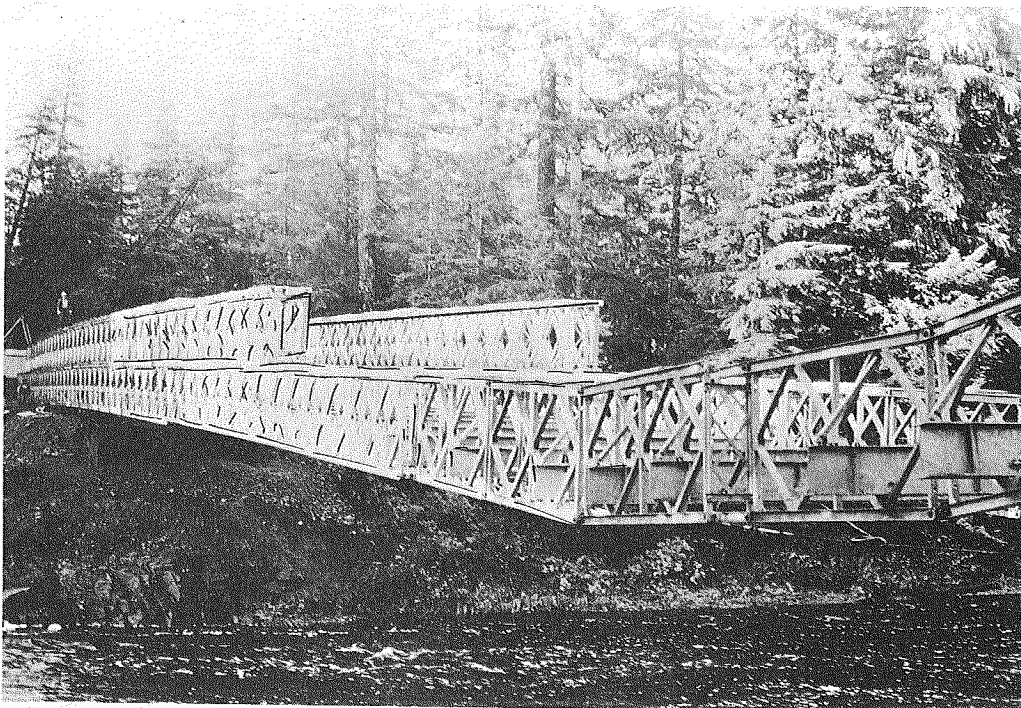


Figure 10.--190-foot (57.91-meter) Acrow Panel Bridge being launched over rollers. Note the turned up launching nose to compensate for the nearly 6 feet (1.83 meters) of cantilever deflection.

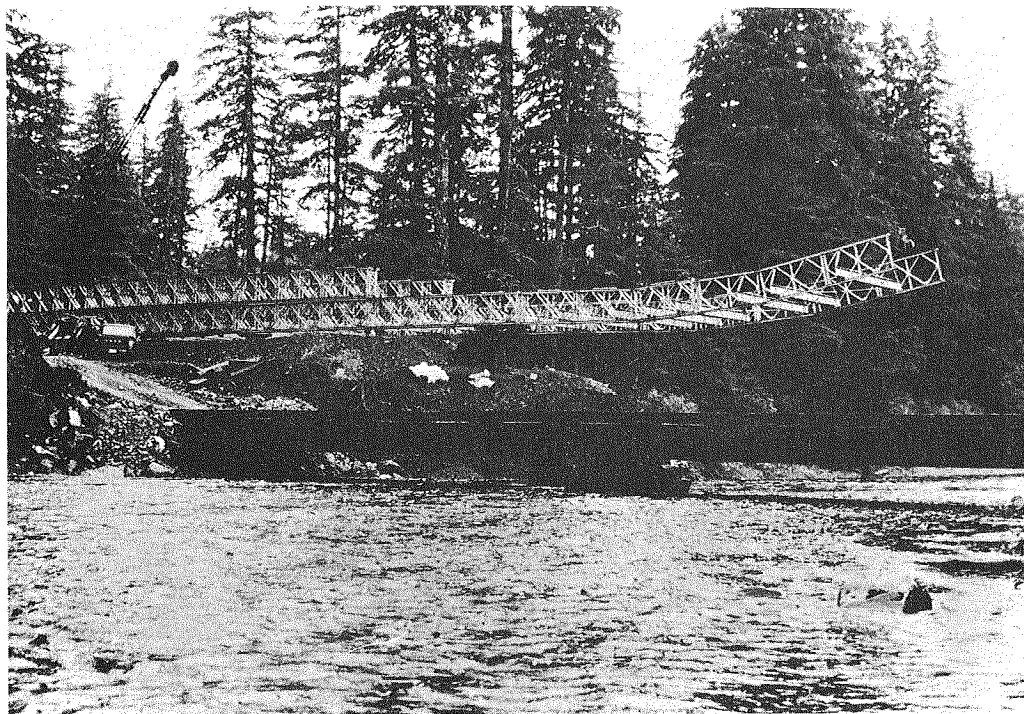


Figure 11.--Launching nose cantilevering over stream.

Just as the Acrow Panel Bridge was being completed, heavy rains caused Hamilton Creek to rise rapidly. Floodwaters nearly overtopped the temporary Hamilton "E-Z" Bridge, which was quickly removed, causing some relatively minor damage to the bridge sections. This minor damage--sustained as a result of the rough handling--is graphic testimony to the toughness of these bridges (figures 13 and 14).

ECONOMIC COMPARISON

Figure 15 compares first costs and reuse costs between the three main types of bridges in use in the Alaska Region--native log stringer bridges, modular portable steel bridges, and conventional constructed-in-place permanent bridges. The reuse cost includes costs associated with removing the superstructure from its previous installation, transporting it to a new site, constructing abutments, and installing the superstructure.



Figure 12.--Balance beam and rocking roller launching assembly. Entire weight of the bridge is balanced on these rollers just as the launching nose touches down on the far side.

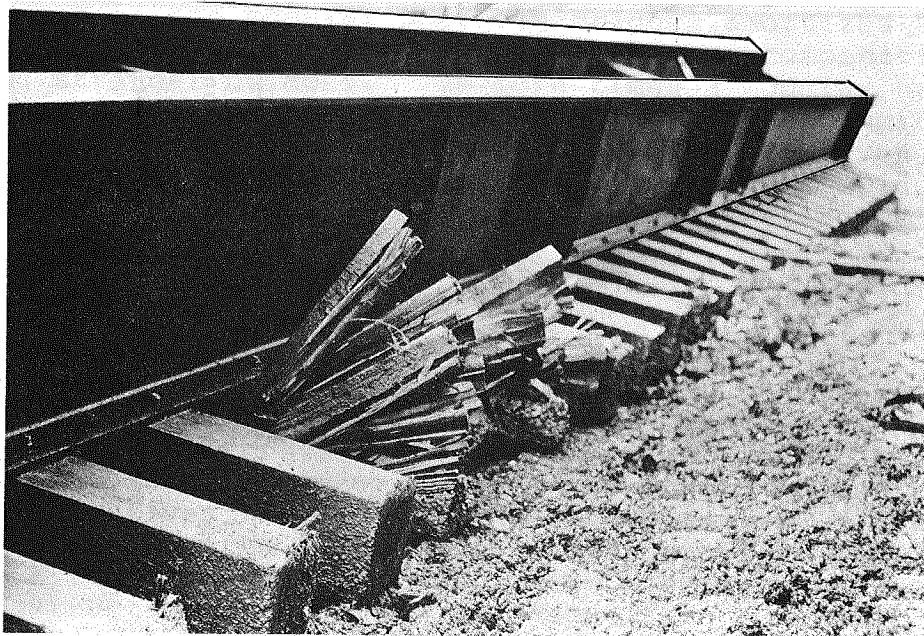


Figure 13.--60-foot (18.29 meter) Hamilton "E-Z" Bridge after removal during flood. A few smashed tie ends and some surface skinning were the only damage, despite the bridge being turned upside down.



Figure 14.--Slight damage sustained while skidding the bridge section up the road during emergency removal. The front end of the bridge dug into the roadway surface on curves. The damage was easily repaired and the bridge was returned to service.

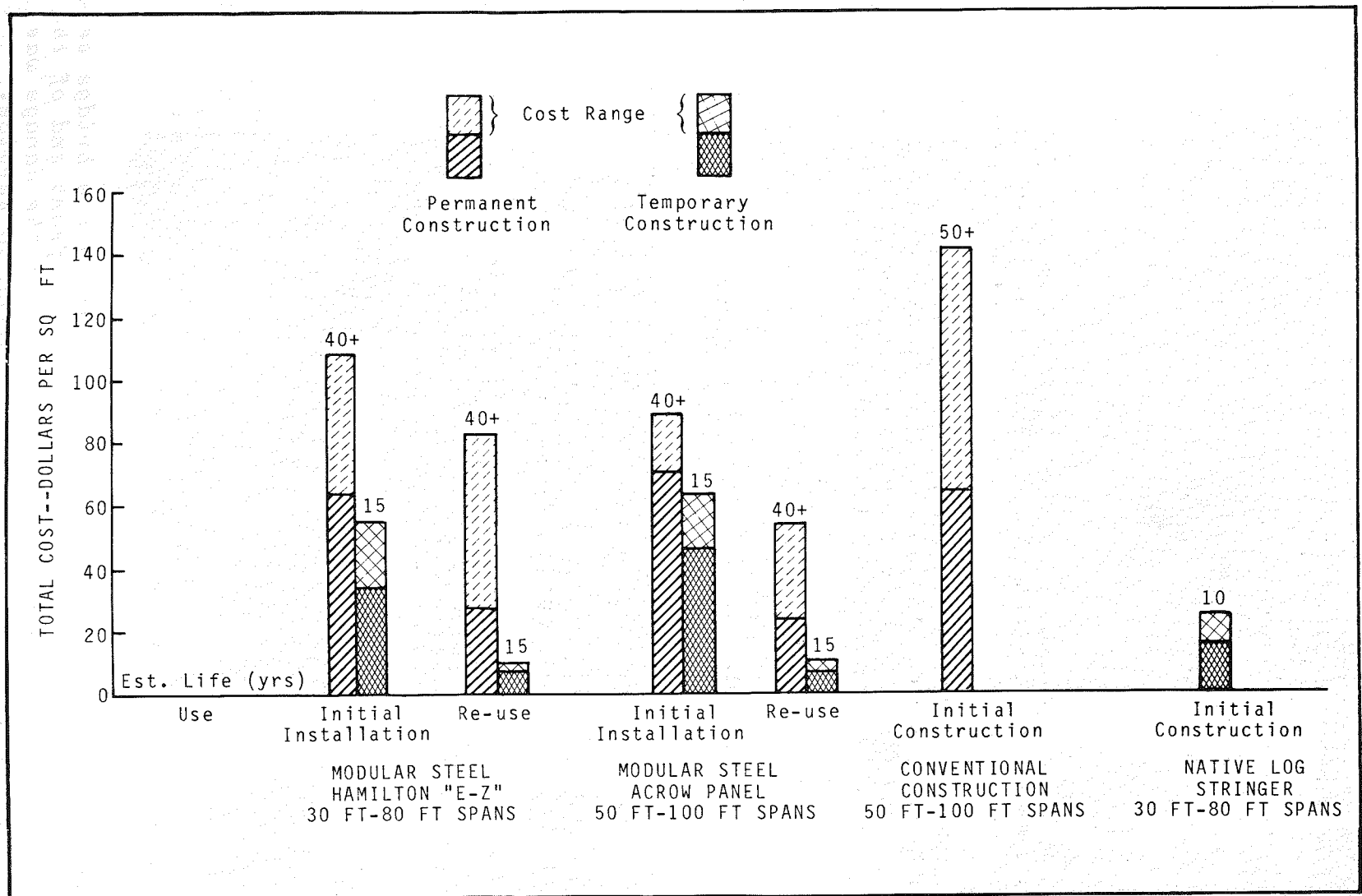


Figure 15.--Cost comparison of bridge types in Alaska region.

Repeated uses of the modular portable bridges amortizes the initial investment over several sites, making them more competitive with the native log stringer bridges. The more times a modular bridge is moved and reused, the "cheaper" it becomes. One economic analysis showed that, for a given set of conditions, a break-even point between the costs of modular bridges and log stringer bridges was reached after five reuses of a modular bridge (Reference 2).

CONCLUSION

The use of modular, portable, reusable bridges on Forest Development Roads in southeast Alaska has filled a gap between native log stringer bridges and conventional permanent bridge construction. This gives the Forest land managers another tool in their consideration of alternatives for development and operation of the Forest Development Road System. The modular design allows rapid installation--for either short-term or long-term use--compared to normal bridge construction procedures, at competitive costs.

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BOUNDARIES

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The Forest Service surveys, delineates, describes, publishes, posts, and manages a multitude of boundary lines. Almost all of these boundaries have some legal significance, some much greater than others.

Boundaries are established for a variety of functional or administrative purposes such as:

Functional

Timber Sales
Range Allotments
Planning Units

Off-Road Vehicle Areas
Use Areas

Administrative

Ranger Districts
National Recreation Areas
Rights-of-Way
Administrative Sites
Mineral Withdrawals
Experimental Forests

Wilderness
National Forests
Roadless Areas
Wild and Scenic Rivers
Special Use Areas
Research Natural Areas

Each of the above examples has significance in terms of permanence, effect, and importance. Some boundaries might never be surveyed or posted (e.g., Ranger Districts); some are posted, but not platted (e.g., Range allotments); some are platted, but not described (e.g., some easements). Those more-or-less permanent boundaries that must be posted, platted (mapped), described, and published, need special attention; many administrative boundaries fall into this category (e.g., Wilderness).

Property boundaries and quasi-property boundaries (e.g., ROW) are surveyed and platted by professional surveyors who are particularly skilled and knowledgeable about the technical and legal aspects of boundary location.

The locations of permanent administrative boundaries should be reviewed by survey professionals. The descriptions of boundaries that

have particular legal significance should also be reviewed to minimize or eliminate ambiguous terms that will weaken the legal sufficiency of the description.

LOCATING PROPOSED BOUNDARIES

When proposing boundaries, the following guidelines should be reviewed:

1. Boundaries that follow natural features generally are easy to describe and locate, and they are economical to post.
2. Often, lines are described as being straight between features. If features are chosen so both are visible at some intermediate point on line, the posting job will be easier.
3. If distance calls are used, they should be kept reasonably short.
4. The use of section subdivision lines or corners not set previously in an original survey should be avoided, because it is often costly to establish them.
5. Similarly, plane coordinate or astronomic positions are expensive to establish. They can be used effectively for lines otherwise difficult to describe, but should be avoided if there are reasonable and less costly alternatives.
6. Contour lines can be used if the end points are well defined.
7. Lines that can be located with simple instruments in a relatively accurate manner can be located more precisely with sophisticated equipment. Locations by compass, altimeter, or eye can serve for some interim purposes; precise locations can be established later if the need arises.
8. A line has no width, being specified only by two end points. These end points must be definite and locatable in order for the line to be.

Proposed boundaries should be described in relationship to permanently fixed or locatable points.

Maps and map markings used to show proposed boundaries as a minimum, should:

1. Be up-to-date topographic maps of at least 2 inches (5.08 cm) to the mile (1.609 kilometers) scale; base Series

1:24,000 scale (7 1/2-minute Quads; 15 minutes in Alaska) maps are preferred. Boundary line intent usually cannot be shown clearly on less detailed maps.

2. Explain the intent of boundary locations with notations where necessary [e.g., parallel with Road #208 and 200 feet (60.96 meters) west of said road].

3. Show the proposed boundary line with black inked lines that are as narrow as possible yet retain legibility.

The proposed boundary should be placed on the map by using one or more of the following methods (listed in descending order of desirability):

1. Natural features that are locatable on the map and on the ground. Examples are:

- a. Live streams
- b. Sharp well-defined ridges
- c. Mountain peaks
- d. Well-defined shorelines of lakes

2. Semipermanent manmade features that are locatable on the map and on the ground. Examples are:

- a. Roads
- b. Trails
- c. Dams
- d. Powerlines and pipelines
- e. Bridges

3. Point-to-Point--A straight line from one locatable point to another.

4. Previously surveyed lines, or legally determined lines. Examples are:

- a. Section and township lines
- b. Section subdivision lines
- c. Metes and bounds property lines
- d. County or State boundaries
- e. National Park or Indian Reservation boundaries

5. A series of bearings and distance between locatable end points (metes and bounds).

6. Along a contour.

7. Using parallels of latitude and meridians of longitude or plane coordinate systems.

Comments on Specific Applications.

1. **Parallel (or setback) Lines.** Lines may be drawn parallel with linear features such as roads, trails, or streams. When setback parallel lines are used, their starting and ending points should be locatable on the map and on the ground. Example: "Along the thread (centerline) of Rock Creek to a point which is 200 feet (60.96 meters) westerly of Road 308, thence along a line parallel with and 200 feet (60.96 meters) west of Road 308." Large setbacks should be avoided as they are difficult to locate.
2. **Water Boundaries.** A notation should be placed on the map to show the intent when rivers or streams are used as boundaries. Only two lines are legally acceptable:
 - a. The thread (or centerline)
 - b. Either bank along the mean high-water line
3. **Property Boundaries.** It is often necessary to follow property boundaries when defining other boundaries. If the property boundary is along a previously surveyed line such as a section line, township line, patented mineral survey or homestead entry survey, location of the line on the map and on the ground is possible, but might be costly because the lines must, by law, be located in the field to high precision. If the property line follows subdivision of section lines that have not been surveyed, the cost of locating them is quite high.
4. **Metes and Bounds.** Metes and bounds segments of a boundary should be limited to those portions that are impossible or difficult to locate by other means; similar limitations apply to points or lines located by reference to plane coordinate systems or parallels of latitude and meridians of longitude. When a line must be drawn cross-country with no topographic control, the length of such lines should be limited as much as possible; both ends of such lines should be at a locatable point. Advanced survey technology makes these types of boundaries easier and cheaper to locate than was true in the past; however, specialized equipment might be necessary.
5. **Contour Lines.** Contour lines are permissible as boundaries when the end points of such boundaries are locatable; an example is the point at which a certain contour crosses a live stream. Advanced technology permits contours to be located with any desired precision, but costs are directly proportional to the precision sought.
6. **Protracted Lines.** Protracted lines of unsurveyed townships should never be used under any circumstances, because they are imaginary lines that have no legal standing.

THE WRITTEN DESCRIPTION

Particular care needs to be given to writing legal descriptions. This work is functionally within the purview of professional surveyors who should prepare the description, or at least review and edit legal descriptions written by others. Due to legal ramifications, boundary descriptions must be carefully worded.

The description of a line must be plottable to be locatable. The converse is not always true; i.e., even though a line can be plotted, it may not be locatable!

Characteristics of good and poor descriptions are:

Good

Specific
Definite
Determinate
Explicit
Subordinated elements
Concise
Consistent
Easily locatable

Poor

Vague
Indefinite
Indeterminate
Ambiguous
Conflicting calls
Redundant
Inconsistent
Difficult or impossible
to locate

A good description will say what is meant, with nothing left to inference or multiple interpretation. The three C's (concise, clear, and complete) of good writing apply!

Particular care should be given to making "solid" calls in the description that definitely fix various points on the line. Such calls can be distinctive natural objects (e.g., mountain peaks), corners of the Public Land Survey, geographical or plane coordinate positions, or intersections of other well-defined lines.

Where boundaries proceed cross-country and do not follow such natural features as streams or ridges, it is even more important to recite calls to definite points in the description. The line between these points can be specified by metes and bounds. This is the only practical way to describe and fix cross-country boundaries.

In some cases, lines might be established by legislation, with no consideration to practical location. These lines, drawn on maps in pencil, can serve as the intended boundary. Describing and locating such lines can be a problem. The only practical way to describe such lines is by metes and bounds, by reduction to a series of short, connected straight lines. This can be done easily by digitizing the original line in a mapping grid system such as State Plane Coordinates or Universal Transverse Mercator Grid. The digitized coordinates along the line are inversed to obtain a series of grid bearings and grid distances.

Grid positions of selected points at frequent intervals on the line should be called in the description, and these can be used later as field control to fix definite points of the line by monumentation.

LOCATING BOUNDARIES

Boundaries located by natural features are generally no problem. Metes and bounds are another matter.

The problem of field location of metes and bounds lines can be dealt with in three ways--field survey methods, aerial photogrammetric methods, and methods employing technologically advanced positioning systems. The selection of the technique to be used for any single monument depends on such factors as cost, availability of nearby geodetic control stations, remoteness, terrain, cover, precision required, and skills and instrumentation available.

ESTABLISHING CONTROL POINTS

Field Survey Methods

Control points called for in the description can be set by field control survey methods to any practical precision. If geodetic control is within a reasonable distance, modern EDM and direction-measuring equipment can be used to triangulate or trilaterate random stations from which the true point can be set by traverse.

Photogrammetric Methods

Photogrammetry offers a variety of techniques to establish control points. The method used will be determined largely by accuracy requirements. The process used is essentially grid position-to-photo-to-ground transfer, using aerial photography and photogrammetry.

Existing photography and map control can be used if accuracy requirements permit. Coordinates of imagery appearing near the control point are measured, and ties from the imagery to the true point are computed. The actual point is established in the field by survey from the selected image points.

Greater accuracy can be achieved by placing random targets near the desired control point, establishing targeted geodetic control, and flying special photography. The coordinates of the random points are determined photogrammetrically, and the true point is established as before.

Positioning Systems

Advanced technology offers convenient and comparatively rapid means of establishing the position of called control points, if the coordinates of the points are known.

At present, these systems are expensive, but it is expected that costs will decrease in the future to a level that will justify more extensive use by the Forest Service. There are at least three systems that could be used: airborne DME, inertial systems, and satellite doppler systems. All three employ mobile computers that calculate positions from signals received from remote ground stations, on-board acceleration sensors, or satellites. Some systems offer the advantage of "homing" on a predetermined point. By writing descriptions with this in mind, the future job of accurate location in the field will be easier.

MONUMENTATION

After control points called for in the description have been located in the field, they should be monumented permanently with brass or aluminum tablets. Accessories to each corner should be established, and a corner perpetuation record should be prepared and filed in the local government official record system.

MARKING AND POSTING

The ultimate objective of any boundary survey program is to enable the boundary line to be marked and posted on the ground. Because permitted activities and regulative authorities change at the boundary, field location is critical and necessary for effective administration of special areas. The marking and posting job can be accomplished using the same methods as those for setting control.

Field Survey Methods

Using instruments appropriate for the precision required (e.g., compass and tape, transit and tape, or theodolite and EDM), a traverse is run from control to control and adjusted, if necessary, for misclosure.

Photogrammetric Methods

Lines can be transferred to stereophotographs or orthophotographs, by plotter or resection from digital terrain models. The line is transferred to the ground using photos and imagery.

Positioning Systems

It is technically feasible, although not presently economically practical, to track a predetermined line using inertial guidance systems. With advances in technology, these systems can become economically available. Future jobs can be handled this way, if provided for today.

BOUNDARY LINE MANAGEMENT

The task of proper boundary line management (locating, describing, posting, and maintaining) has often been ignored by the Forest Service. In recent years great emphasis has been placed on property boundaries, and much money and effort have been and are being invested in marking these lines.

Perhaps not as intensive an effort is needed for other boundaries, but none the less, problems and conflicts can be avoided by paying proper attention to careful description, posting in critical areas, and maintenance of these lines.

Boundary line conflicts can occur in two ways--location questions on large and small scale. The first type can be characterized by the question "where?" or "what ridge?" does the line follow. Problems of this nature can be avoided by careful description.

Conflicts of the second type--small-scale uncertainties, often of the order of 1 meter or less--can be avoided by proper marking on the ground.

Management of boundaries is a neglected area that needs more attention if future problems of conflict will be avoided. Engineers and surveyors need to be more involved with these matters.

WASHINGTON OFFICE NEWS

CONSULTATION AND STANDARDS

*Walter E. Furen
Assistant Director*

*JOB CORPS FACILITY SURVEYS
John Lupis
Engineer, Human Resource Programs*

As provided by the Code of Federal Regulations, Title 29, Section 97A.27, a facility survey is required every 2 years on all Job Corps Centers. Pursuant to this requirement, the Department of Labor has retained two Washington, D.C.-based consulting firms (Environmental Management Consultants, Inc. and Leo A. Daly Co.) to conduct the surveys. Final survey reports for all Forest Service Centers are scheduled for completion before January 1, 1981.

The facility survey consists of four basic phases:

1. An on-site inspection of Center facilities by a team of architects and engineers, normally over a 2- or 3-day period.
2. Preparation of a preliminary report based on the review team's findings and other supporting data provided by involved Forest Service personnel.
3. A meeting of representatives from Regional and local Forest Service offices, Department of Labor Regional offices, and the review team to discuss the report recommendations, review the report for errors or omissions, and jointly develop priorities for recommended facility projects into a 5-year plan.
4. Preparation of the final report, which will include:
 - a. An outline of existing Center utilization, a real estate description, and a description of the facility and its condition as found at the time of the survey.
 - b. A section on potential for handicapped access, solar energy applications, and energy conservation opportunities, along with a description of Center maintenance and utility operations.

- c. An update of capital funding (Quality of Life) and expenditures and projects completed in the last 2 fiscal years.
- d. Repair or replacement projects recommended by the survey team, and a listing of required equipment (replacement and additions). Both facility and equipment needs will be prioritized over a 5-year period.
- e. A summary on findings of overall facility operations.

The final report for each center will serve as an excellent master development plan for that Center and, at the same time, provide the Department of Labor a cumulative projection of the required "capital improvement" funding necessary to provide safe and efficient facilities and equipment at all Job Corps Centers.

CHANGES TO FIELD NOTES

The changes below are intended for insertion into the January-February 1980 Field Notes. Each paragraph should be cut out, as indicated, and stapled securely over its corresponding paragraph.

In the article titled "Solar Bathhouse and Toilet Facilities," on page 6, replace the first paragraph with the following:

(cut on this line)

The four-unit toilet has eight collectors (two different sizes for best use of the available roof area), with a total area of 246 square feet (674.4 square meters). The storage tank is 530 gallons (2006.05 liters).

(cut on this line)

On the same page, replace the fourth paragraph with the following:

(cut on this line)

The bathhouse has 10 collectors, with a total collector area of 644 square feet (59.83 square meters), and two 530-gallon (2006.05-liter) storage tanks. The toilet and bathhouse will begin operation in the 1980 recreation season.

(cut on this line)

In the article titled "Solar Attic Dwelling," on page 10, replace the third and fourth paragraphs with the following:

(cut on this line)

Heated air enters the rock bin from the upper attic chamber in the heat-storage mode at, say, 110°F (43.3°C), that is about the peak attic temperature anticipated. The first rock it reaches rises to this temperature. As the air travels horizontally through the rock bin, it gradually raises the temperature of the rocks in the direction of air movement, until it exits via ducts for its return trip to the attic at, say, 68°F (20.0°C).

To remove heat from storage, the air flow is reversed. Then air enters storage at about 68°F (20.0°C), and exits at 110°F (43.3°C) (or whatever temperature the rock has attained), since it reaches the hottest rock last. If storage is exhausted, the heat pump supplies the heat.²

(cut on this line)

In the same article, on page 11, replace the third paragraph with the following:

(cut on this line)

The solar water heating system includes an air-to-water heat exchanger, differential thermostat, circulating pump, and solar electric water tank. The heat exchanger consists of copper tubing with aluminum fins painted flat black; this is attached to the underside of the solar glazed rafters in the upper attic. The plumbing is arranged for a direct circulation loop, where the domestic water supply is circulated through the water tank. Freeze protection for the heat exchanger is provided by a drain-down, solenoid-operated valve that opens when the upper attic temperature drops below 35°F (1.67°C).

(cut on this line)

INVITATION TO READERS OF *FIELD NOTES*

Every reader is a potential author of an article for *Field Notes*. If you have a news item or short article you would like to share with Service engineers, we invite you to send it for publication in *Field Notes*.

Material submitted to the Washington Office for publication should be reviewed by the respective Regional Office to see that the information is current, timely, technically accurate, informative, and of interest to Forest Service Engineers (FSM 7113). The length of material submitted may vary from several short sentences to several typewritten pages; however, short articles or news items are preferred. All material submitted to the Washington Office should be typed double-spaced, and, ideally, all illustrations should be original drawings, glossy prints, or negatives.

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Field personnel should submit material for publication or questions concerning *Field Notes* to their Regional Coordinators:

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