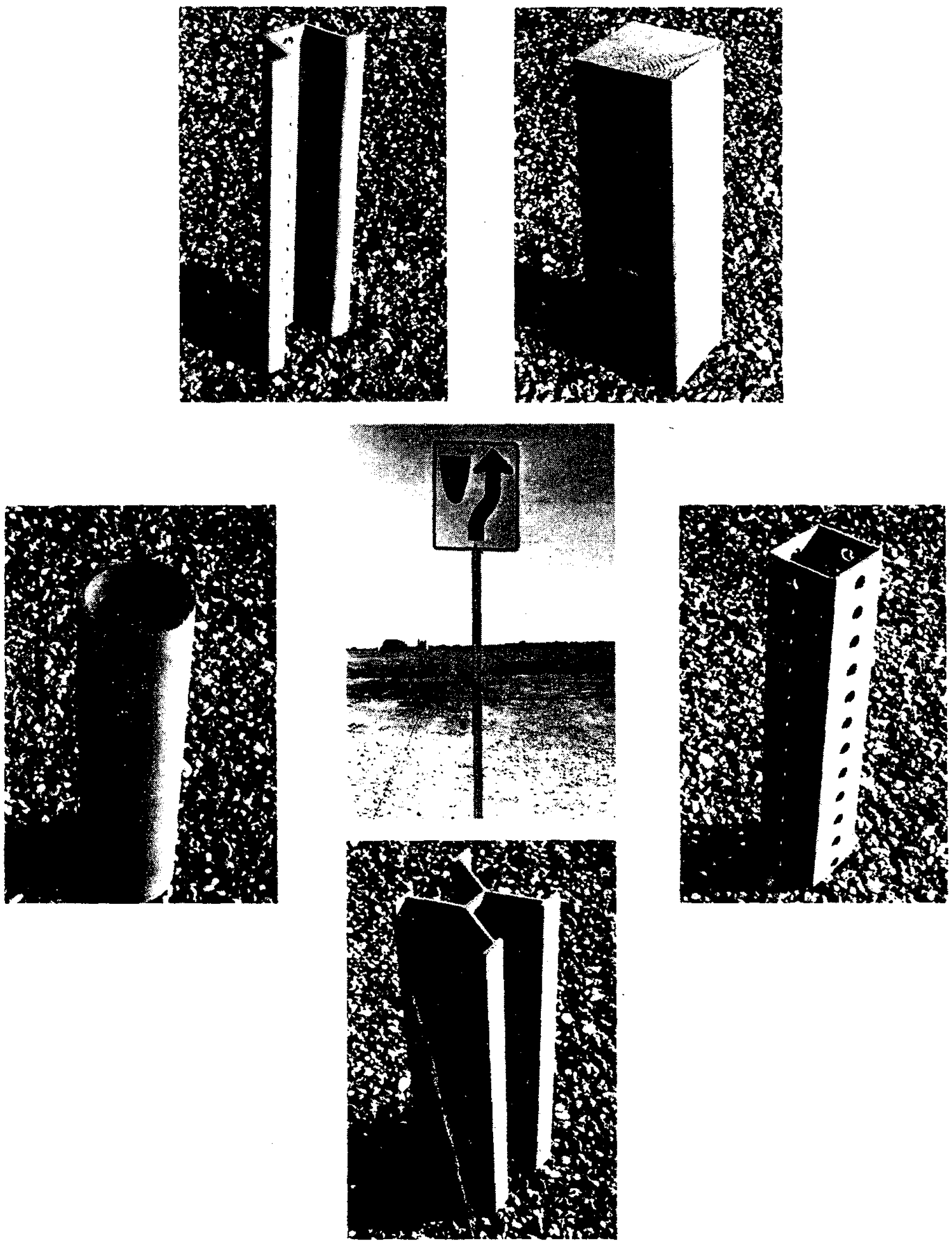
TECHNOLOGY SHARING REPORT 80-222

# STATE OF THE PRACTICE IN SUPPORTS FOR SMALL HIGHWAY SIGNS



U.S. DEPARTMENT OF TRANSPORTATION
Federal Highway Administration
Offices of Research and Development
Implementation Division
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APRIL 1980

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TECHNOLOGY SHARING REPORT 80-222

# STATE OF THE PRACTICE IN SUPPORTS FOR SMALL HIGHWAY SIGNS

Prepared for

**U.S. DEPARTMENT OF TRANSPORTATION**
**FEDERAL HIGHWAY ADMINISTRATION**

**APRIL 1980**

by
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# FOREWORD

The results of the project entitled, "Cost Effectiveness of Small Highway Sign Supports," are presented in six reports and a 16 mm movie. The basic purpose of this study was to develop objective criteria and methodologies to assist engineers in the selection of cost-effective sign support system.

The subject report discussed the results of a survey of existing practices. Also presented is an evaluation of current support systems based on existing crash data and performance guidelines.

The other reports developed as part of this study are:

| | |
|---|---|
| Cost Effectiveness of Small Highway Sign Supports - A Summary Report | FHWA/RD-80/501 |
| Crash Tests of Small Highway Sign Supports | FHWA/RD-80/502 |
| Crash Tests of Single Post Sign Installations Using Subcompact Automobiles | FHWA/RD-80/503 |
| Crash Tests of Rural Mailbox Installations | FHWA/RD-80/504 |
| Guidelines for Selecting a Cost-Effective Small Highway Sign Support System | FHWA-IP-79-7 |

A 16 mm movie entitled, "Small Sign Supports," was also developed.

These reports and movie were prepared by the Texas A&M Research Foundation, College Station, Texas. Copies of the reports are being distributed in accordance with the numbers agreed upon between each Regional Office and the Implementation Division for normal report distribution. Additional copies are available from the National Technical Information System, Springfield, Virginia 22161.

For additional information, please contact the Federal Highway Administration Offices of Research and Development, Implementation Division, (HDV-21), Washington, D.C. 20590.

# GLOSSARY

*Breakaway Mechanism* - A device which is designed to minimize the collision hazard of an appurtenance. Slip bases, frangible couplings, weakened sections (by drilling holes or making notches), and load concentration couplers are examples of breakaway mechanisms used on sign supports.

*Clear Zone* - That roadside border area, starting at the edge of the traveled way, available for safe use by errant vehicles. Establishment of a minimum width clear zone implies that rigid objects and certain other hazards with clearances less than the minimum width should be removed, relocated to an inaccessible position or outside the minimum clear zone, remodeled to make safely traversable or breakaway, or shielded.

*Collision Hazard to Motorist* - The relative danger a roadside appurtenance presents to a motorist.

*Collision Repair Maintenance* - All activities needed to restore an installation to standard conditions after a vehicle collision.

*Cost-Effective Sign Installation* - One that is economical in terms of tangible benefits produced by money spent, i.e., initial cost, normal maintenance costs, collision repair costs, and those costs incurred by motorists who collide with the installation.

*Crashworthy Sign Installation* - One that can be impacted by a vehicle at or below the anticipated operating speed of the roadway with low probability of serious injury to the vehicle's occupants.

*Fixed Sign Support* - One which is designed to remain intact upon impact. Such supports are to be used only in areas inaccessible by errant motorists, e.g., behind traffic barriers or beyond the clear zone of the roadway.

*Normal Maintenance* - All activities, other than those due to vehicle impacts, needed to keep an installation up to standards.

*Operating Speed* - The highest speed at which reasonably prudent drivers can be expected to operate vehicles on a section of highway under low traffic densities and good weather conditions. This speed may be higher or lower than posted or legislated speed limits or nominal design speeds where alignment, surface, roadside development or other features affect vehicle operation.

*Plastic Hinge* - A weakened plane on the support post, usually just below the bottom of the sign panel, about which the support post is designed to rotate upon vehicle impact.

*Stub Post* - That portion of the sign support structure to which the signpost is attached. The stub may be driven in soil or embedded in concrete. Some sign supports have no stub, i.e., a full length post is driven to a desired depth and no attachment is necessary.

*Support Post* - That portion of the sign support structure to which the sign panel is attached. The base of the support post is either attached to a stub post or embedded in the soil or a concrete footing.

*Yielding Sign Support* - One which is designed to bend over upon impact. Some yielding supports fracture after impact, usually during high-speed impacts.

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# I. INTRODUCTION

Small highway signs are supported in a variety of ways and by a variety of materials. Rolled steel and aluminum shapes, wood posts, and steel and aluminum pipes are often used to support small signs. In some cases a trussed design is employed. Embedment is accomplished by either driving the post into the soil, drilling and backfilling after placement of the post, or by placing the post in a concrete footing. Upon impact by an errant vehicle, the base of the support may be designed to break away, yield and bend over, or to be "rigid" and do neither. The latter design is acceptable only if placed behind a protective traffic barrier or if its probability of impact by errant vehicles is extremely low. It can be seen that the matrix of possible support configurations is very large.

A sign support system must be durable and structurally adequate for the given wind and ice loads. Other desirable characteristics of a sign support system are: (1) relatively low material cost, (2) relatively low installation and maintenance cost, (3) easy to install, (4) readily available materials, and (5) that it not present a hazard to the motorist. Before selecting a system, the engineer should evaluate the degree to which the available supports meet the characteristics.

This study has as its basic purpose the development of objective criteria and methodologies to assist the engineer in the selection of a sign support system. To accomplish this objective, four tasks were required. These were to (1) survey existing practices, (2) evaluate the crashworthiness of widely used support systems and promising new systems, (3) develop methodologies whereby candidate systems could be evaluated on a cost-effective basis, and (4) to the extent possible, identify the relative cost-effectiveness of current systems. This report presents the results of Task 1 and a part of Task 2 as described below. Results from the other tasks will be published in subsequent reports.

It is the intent of this report to provide state-of-the-practice information on small sign supports. Included are statistical data on sign use, design data, cost data, and maintenance data. Chapter II describes the methods used to obtain the desired information. Chapter III contains a summary of the more significant results of the survey. Detailed data on all phases of the survey are given in Appendix C. These data relate primarily to signs now in service. Some agencies indicated they were in the process of changing their standards while others indicated they were contemplating changing standards. A literature search was also conducted to determine the extent to which existing sign support systems met current safety standards. Results of this search are included in Chapter IV.

*Small* signs were arbitrarily defined as those having a total panel area less than 50 square feet (4.65 square meters). As such, the major portion of the study relates to supports for regulatory signs and warning signs. Some guide signs are also in this category. *No attempt is made in this report to evaluate the current sign support systems in terms of their cost-effectiveness.* Such an evaluation is planned in the latter phase of the contract.

Note: Equivalent metric units are shown where appropriate in most cases. Where not shown, the conversions may be made as follows:

1 pound-mass = 0.453 kilograms

1 pound-force = 4.45 newtons

1 mile/hour = 0.305 meters

1 inch = 0.0254 meters

# II. DETAILS OF SURVEY

Collection of desired information on existing small sign supports was accomplished by two methods. Initially, a questionnaire was prepared and mailed to various governmental agencies and other interested agencies. Subsequent to the mail survey, follow-up interviews were made with a select number of state highway and city officials. Further details of the data collection are given in the following sections.

## II-A. Mail Survey

### II-A-1. Design

An objective evaluation of a given sign support system requires a thorough knowledge of the characteristics of the system. These characteristics include factors such as initial cost, maintenance cost, crashworthiness, and manpower and equipment needed to install and maintain the system. To determine these and other characteristics of currently used support systems, a comprehensive questionnaire was developed.

Separate questionnaires were designed for government agencies, sign support suppliers, and sign contractors to collect the appropriate data from each group. A copy of the questionnaire for government agencies is given in Appendix A. Questionnaires for sign suppliers and contractors were similar to the government form but were reduced where appropriate.

Before the questionnaires were finalized and approved, they were pretested by sending them to several state agencies, sign suppliers, and sign contractors. Also, copies were sent to several Federal Highway Administration officials for their review and comments.

## II-A-2. Selection and Characteristics of Recipients

The data collection plan called for mailing out questionnaires to all of the 50 state highway agencies and to a selected number of appropriate federal agencies, state turnpike authorities, cities, counties, and sign suppliers and contractors. The selection of those other than state highway agencies was based on the following criteria:

(1) Must have the responsibility of supplying, installing, and/or maintaining small sign systems on highways or streets.

(2) Must supply, install, and/or maintain enough small signs to provide reasonably accurate cost and crashworthiness data.

(3) Must be recommended by state or federal highway officials as being potentially good respondents because the names of the appropriate officials in the organization or company are known.

A total of 275 questionnaires were mailed. The selections were made from lists of 50 states, 59 turnpikes, 3,141 counties, 1,300 of the largest cities, and approximately 450 sign suppliers and contractors.

Table II-A-1 shows the actual number of questionnaires that were mailed and received along with the response percentages of each type of respondent. The overall response of 45 percent is considered very good for a mail questionnaire.

The survey respondents are characterized on the basis of type and location. Table II-A-2 shows the number and percentage of respondents by type.

Table II-A-1

Rate of Response to the Sign Support Survey Questionnaire, by Type of Respondents Sampled

| Type | Number Mailed | Number Received | Response Percentage |
|---|---|---|---|
| Government Agencies | | | |
| State Highway Departments | 50 | 48 | 96 |
| Cities | 84 | 36 | 43 |
| Counties | 62 | 16 | 26 |
| Toll Roads | 11 | 4 | 36 |
| Federal Agencies | 12 | 6 | 50 |
| Territories | 2 | 1 | 50 |
| Subtotal | 221 | 111 | 50 |
| Sign Support Suppliers | 24 | 9 | 38 |
| Sign Support Erectors | 30 | 5 | 17 |
| Total Respondents Sampled | 275 | 125 | 45 |

Table II-A-2

Number and Percentage of Respondents
by Type of Respondent

| Type of Respondent | Respondents Number | | Respondents Percent* | |
|---|---|---|---|---|
| Government Agencies | 111 | | 88.8 | |
| State Highway Departments | | 48 | | 38.4 |
| Cities (includes Washington, D.C.) | | 37 | | 29.6 |
| Counties | | 16 | | 12.8 |
| Toll Roads | | 4 | | 3.2 |
| Federal Agencies | | 6 | | 4.8 |
| Sign Support Suppliers | 9 | | 7.2 | |
| Sign Support Contractors | 5 | | 4.0 | |
| Total Respondents | 125 | | 100.0 | |

*Percent of all respondents.

Almost 89 percent are government agencies, with the state highway departments making up the largest group of this type. Sign support suppliers make up 7.2 percent and contractors account for the remaining 4.0 percent.

Table II-A-3 shows the geographical or regional distribution of the respondents. Figure II-A-1 shows the states included in each region. The Standard Highway Administrative Regions were used for a geographical breakdown mainly for convenience. However, there was some speculation that agencies within the same region would use similar sign support standards. Cross-tabulating by region should reveal the amount of differences in sign designs and costs that may exist among regions. Each region also had from 4 to 8 respondent cities and/or counties represented in the survey. Three regions have toll road respondents, and 4 regions have federal agency respondents. Therefore, the different types of respondents are scattered reasonably well across the regions.

It is noted that the amount of data provided varied from respondent to respondent. Some provided a response to all of the requested information while others provided only a partial amount.

## II-B. Follow-Up Interviews

To fill voids in the mail survey, trips were made by the researchers to a representative group of state and city highway agencies. A total of 12 such agencies were visited. In addition to obtaining the desired data, the visits served to acquaint the researchers with a cross-sectional view of selection philosophies, field experiences, cost factors, and problems related to supports for small signs. Without exception, each agency was very receptive and each provided additional data that will

Table II-A-3

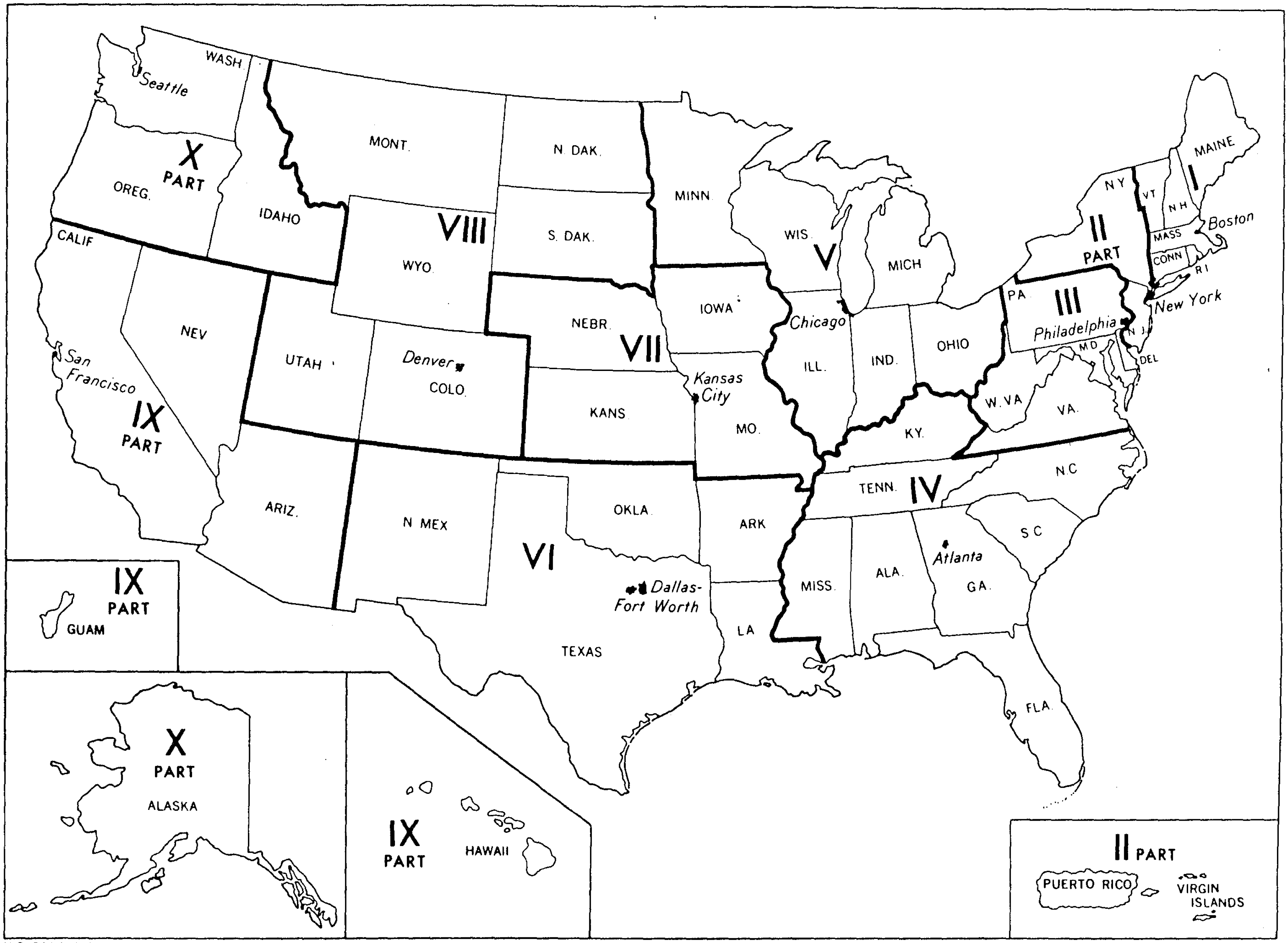
Regional Location of Respondents
by Type of Respondent

| | Type of Respondents | | | | |
|---|---|---|---|---|---|
| | Government Agencies | | | | |
| Region* | State | Other** | Sign Suppliers | Sign Contractor | Total |
| | -- | -- | Number | -- | -- |
| Region 1&2 | 8 | 10 | 1 | 1 | 20 |
| Regions 3 | 5 | 6 | 2 | 1 | 14 |
| Region 4 | 8 | 4 | 0 | 0 | 12 |
| Region 5 | 6 | 9 | 4 | 2 | 21 |
| Region 6 | 4 | 10 | 0 | 1 | 15 |
| Region 7 | 4 | 8 | 1 | 0 | 13 |
| Region 8 | 6 | 6 | 1 | 0 | 13 |
| Region 9 | 3 | 5 | 0 | 0 | 8 |
| Region 10 | 4 | 5 | 0 | 0 | 9 |
| Total Respondents | 48 | 63 | 9 | 5 | 125 |

*See Figure 1 for location of designated regions.

**Includes federal agencies and territories, state turnpikes, cities, and counties.

# FIGURE II-A-1. STANDARD FEDERAL ADMINISTRATIVE REGIONS




U.S. DEPARTMENT OF COMMERCE SOCIAL AND ECONOMIC STATISTICS ADMINISTRATION BUREAU OF THE CENSUS enhance the state-of-the-practice report. An ancillary comment is offered for those planning detailed questionnaires of the type used in this study. It is suggested that selected visits be made prior to conducting the survey. In this way, firsthand information can be gained regarding availability of data, the form the data is kept in, and which department or division within the agency maintains the data. An effort was made to gain this information in the current study by trial surveys sent through the mail to selected agencies. Although this proved to be beneficial, it is now clear that more information could have been obtained by eliminating some questions, modifying others, and by adding some.

The researchers also either visited or were visited by companies involved with the production and marketing of sign supports and/or breakaway devices. Valuable data were also gained through these interviews.

## II-C. Data Analysis

Data gathered through the survey was coded and stored on a computer file. Analysis and cross-tabulation of the data was then accomplished through small utility programs written specifically to extract the desired data from the file. This procedure provided a very convenient way to manage the large volume of information. The file also provides a good data base on small signs for future studies.

# III. SUMMARY OF SURVEY FINDINGS

A detailed presentation and discussion of the survey results are given in Appendix C. Highlights and points of special interest are presented in this chapter.

## III-A. General Data on Highway Signs

The initial part of the questionnaire was designed to determine information on highway signs in general, such as the number of signs in place, level of sign maintenance costs, records maintained on signs, etc. Of special significance in this section was the number of sign installations in place and the cost to maintain these installations. This information is summarized in Tables III-A-1 and III-A-2 for all government agencies combined, for state agencies only, and for city and county agencies only. Although not listed, values for the federal agencies can be determined from the given values by subtracting the state, city and county values from the combined government values.

These data point out that a vast number of signs are now in place along the nation's highways and streets. Approximately 20 percent of the respondents, most of which were state highway or transportation agencies, have 200,000 or more sign installations. Of special significance is that a large percentage of all sign installations fall within the small sign category, and that most of the small sign installations have a single support.

## Table III-A-1. Number of In-Place Signs

| Question and Type of Response | All Government Agency Respondents: Number | All Government Agency Respondents: Percent | State Agency Respondents: Number | State Agency Respondents: Percent | City and County Agency Respondents: Number | City and County Agency Respondents: Percent |
|---|---|---|---|---|---|---|
| **Number of All Signs in Place?** | | | | | | |
| Less than 20,000 | 19 | 17 | 0 | 0 | 16 | 30 |
| 20,000 - 49,999 | 16 | 15 | 6 | 12 | 9 | 17 |
| 50,000 - 99,999 | 17 | 15 | 9 | 19 | 6 | 11 |
| 100,000 - 199,999 | 14 | 13 | 7 | 15 | 7 | 13 |
| 200,000 or more | 21 | 19 | 16 | 33 | 3 | 6 |
| No response | 24 | 21 | 10 | 21 | 12 | 23 |
| **Percentage of All Signs of Small Type?[a]** | | | | | | |
| Less than 20% | 1 | 1 | 0 | 0 | 1 | 2 |
| 20% to 40% | 0 | 0 | 0 | 0 | 0 | 0 |
| 40% to 60% | 2 | 2 | 0 | 0 | 0 | 0 |
| 60% to 80% | 11 | 10 | 10 | 21 | 0 | 0 |
| 80% or more | 90 | 81 | 34 | 71 | 50 | 94 |
| No response | 7 | 5 | 4 | 8 | 2 | 4 |
| **Percentage of Small Type Signs With Single Post Support System?** | | | | | | |
| Less than 20% | 5 | 4 | 1 | 2 | 3 | 5 |
| 20% to 40% | 0 | 0 | 0 | 0 | 0 | 0 |
| 40% to 60% | 5 | 5 | 2 | 4 | 1 | 2 |
| 60% to 80% | 21 | 19 | 17 | 36 | 2 | 4 |
| 80% or more | 73 | 66 | 23 | 48 | 45 | 85 |
| No response | 7 | 6 | 5 | 10 | 2 | 4 |
| Total Respondents | 111 | 100 | 48 | 100 | 53 | 100 |

[a]Signs having panel areas of 50 $ft^2$ (4.65 $m^2$) or less are designated as small.

## Table III-A-2. Maintenance Expenditures

| Question and Type of Response | All Government Agency Respondents | | State Agency Respondents | | City and County Agency Respondents | |
|---|---|---|---|---|---|---|
| | Number | Percent | Number | Percent | Number | Percent |
| **Total Annual Maintenance Expenditure?**[a] | | | | | | |
| Less than $1,000,000 | 33 | 30 | 3 | 6 | 28 | 53 |
| $1,000,000 to $9,999,999 | 20 | 18 | 9 | 19 | 8 | 15 |
| $10,000,000 to $49,000,000 | 19 | 17 | 17 | 35 | 0 | 0 |
| $50,000,000 or more | 11 | 10 | 10 | 21 | 0 | 0 |
| No response | 28 | 25 | 9 | 19 | 17 | 32 |
| **Percentage of Annual Maintenance Expenditure Devoted to Signs?** | | | | | | |
| Less than 20% | 44 | 40 | 29 | 60 | 8 | 16 |
| 20% to 40% | 22 | 20 | 7 | 15 | 15 | 28 |
| 40% to 60% | 6 | 5 | 1 | 2 | 5 | 9 |
| 60% to 80% | 3 | 3 | 1 | 2 | 2 | 4 |
| 80% or more | 3 | 3 | 0 | 0 | 2 | 4 |
| No response | 33 | 30 | 10 | 21 | 21 | 39 |
| **Percentage of Annual Maintenance Expenditure Devoted to Small Signs?**[b] | | | | | | |
| Less than 20% | 42 | 38 | 27 | 57 | 9 | 17 |
| 20% to 40% | 17 | 15 | 3 | 6 | 14 | 26 |
| 40% to 60% | 2 | 2 | 1 | 2 | 6 | 11 |
| 60% to 80% | 2 | 2 | 0 | 0 | 1 | 2 |
| 80% or more | 15 | 14 | 3 | 6 | 11 | 21 |
| No response | 33 | 30 | 14 | 29 | 12 | 23 |
| **Total Respondents** | 111 | 100 | 48 | 100 | 53 | 100 |

[a]Expenditures for the immediate past fiscal year.

[b]Signs having panel areas of 50 $ft^2$ (4.65 $m^2$) or less.

From Table III-A-2 one can see the relationship between total annual maintenance expenditures for the respective agencies and the percentage of the total devoted to all signs and to small signs. Sign maintenance involves repair and/or replacement due to vehicle impact or vandalism or natural wear, and normal upkeep such as cleaning or painting. Approximately 30 percent of all respondents indicated that they spend 20 percent or more of their maintenance budget on small signs. In general, the cities and counties spend a greater percentage of their maintenance budget on signs than do the state highway agencies. In either case, the actual expenditures devoted to sign maintenance are significant. This underlines the importance that should be placed on maintenance when selecting a sign-support system. It was found that many agencies select a sign-support system based almost entirely on its initial cost, without due consideration of its future costs.

Other results found in the initial phase of the survey were that: (1) most agencies do not maintain an inventory of sign installation, records of maintenance activities, or accident data; (2) while most agencies contract the installation of new signing projects, most do not contract for their sign maintenance; and (3) very few agencies conduct cost-effective analysis of their signing. As a consequence of Item 1 above, responses to the survey were lacking in detail in many cases.

## III-B. General Data on Sign Support Systems

An effort was made to determine criteria used by agencies in selecting sign support systems and to determine the characteristics and extent of use of various sign support systems used within a given agency. Summarized in the following sections are the more significant results of this phase of the survey.

III-B-1. Selection Criteria

Table III-B-1 shows how the different agencies ranked four selection factors. It is interesting to note that with the exception of the cities, all agencies ranked the *collision hazard to motorist* as the most important factor in selecting a support system. Such a result was expected, however, since operating speeds on most city streets and highways are considerably lower than those on state and county roads, and the impact hazard is therefore less. The second most important factor given by most of the agencies was the *initial and maintenance costs*.

III-B-2. Designs

Of particular interest to this study were the various types of supports used and the extent of their use. Table III-B-2 shows this information for single and multiple support installations. General details and photographs of the widely used supports are given in Figures III-B-1 through III-B-11.

For *single post installations*, the U-post design ranks as the most widely used support. Within the reporting state highway agencies, 29.8 percent of all single post installations (over 2.3 million) were of the U-post design, 28.9 percent (over 2.2 million) were wood posts, 25.3 percent (over 2 million) were round or oval pipe, 13.6 percent (over 1 million) were square or rectangular tubes, and the remainder

Table III-B-1

Ranking of Sign Support Selection Factors

| Sign Support Selection Factors | Ranking by Type of Respondent[a] | | | | |
|---|---|---|---|---|---|
| | State Agencies | Cities | Counties | Other | Total |
| Availability of Materials for Replacement | b | 3 | 4 | 3 | 4 |
| Amount of Maintenance Required | b | 1 | b | 2 | 3 |
| Initial and Maintenance Costs | 2 | 2 | b | 4 | 2 |
| Collision Hazard to Motorists | 1 | 4 | 1 | 1 | 1 |
| Total Respondents (Number)[c] | (46) | (35) | (15) | (9) | (105) |

[a]Based on a score computed by multiplying the rank given the factor by the number of respondents. The lowest aggregate score is ranked first, the next lowest score is ranked second, etc.

[b]Tie score between two of the factors.

[c]Six respondents failed to rank one or more of the above factors.

## Table III-B-2. Extent of Use of Single and Multiple Post Sign Supports[a]

| Type of Material/ Cross-Sectional Shape | Single Post: State Agencies | Single Post: Cities | Single Post: Counties | Single Post: Other | Single Post: Total | Multiple Posts: State Agencies | Multiple Posts: Cities | Multiple Posts: Counties | Multiple Posts: Other | Multiple Posts: Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | Percent of Signs | | | | | Percent of Signs | | | | |
| **Steel** | | | | | | | | | | |
| "U" Single | 29.8 | 48.6 | 48.3 | 36.6 | 34.0 | 32.4 | 1.8 | 97.8 | 4.5 | 29.7 |
| "U" Back to Back | 1.2 | 0.0 | 0.0 | 0.0 | 0.9 | 3.4 | 0.0 | b | 0.0 | 3.0 |
| Square of Rectangular Tube | 13.6 | 10.1 | 13.4 | 2.9 | 12.7 | 7.0 | 11.1 | b | 2.2 | 7.2 |
| Round or Oval Pipe | 25.3 | 31.6 | 3.3 | 12.0 | 24.8 | 4.9 | 81.3 | b | b | 12.4 |
| Tapered Pipe | b | 0.0 | 0.0 | 0.0 | b | b | 0.0 | 0.0 | 0.0 | b |
| Beam (I, S, W, or H) | 0.2 | 0.0 | 0.0 | b | 0.2 | 16.7 | 0.0 | 0.0 | 3.8 | 14.6 |
| Angle (Z) | b | 1.3 | 0.0 | 0.0 | 0.2 | b | c | 0.0 | 0.0 | c |
| **Aluminum** | | | | | | | | | | |
| "U" Single | c | c | 0.0 | 0.0 | c | c | b | 0.0 | 0.0 | c |
| Round or Oval Pipe | 0.5 | 1.7 | 2.5 | 0.2 | 0.8 | 0.7 | 2.3 | 2.2 | 0.3 | 0.9 |
| Beam (I, S, W, or H) | c | b | c | 0.0 | 0.1 | 6.6 | 0.0 | 0.0 | 0.0 | 5.8 |
| Angle (Z) | b | 0.0 | 0.0 | 0.0 | b | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Wood** | | | | | | | | | | |
| Square or Rectangular | 28.9 | 6.3 | 32.5 | 38.0 | 25.6 | 27.4 | 3.5 | 0.0 | 53.6 | 25.1 |
| Round | 0.5 | 0.0 | 0.0 | 4.2 | 0.5 | 0.9 | 0.0 | 0.0 | 15.5 | 1.0 |
| Combination | 0.0 | 0.0 | 0.0 | 6.1 | 0.1 | b | 0.0 | 0.0 | 20.1 | 0.3 |
| **Plastic** | | | | | | | | | | |
| Round Pipe | 0.0 | 0.4 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total (000) | (7,901) | (1,699) | (576) | (230) | (10,406) | (2,126) | (245) | (27) | (39) | (2,436) |

[a]Based on the number of small signs in place, as reported by the respondents. This table does not represent all of the signs in place because a few respondents either did not estimate the percentage of usage of certain types of signs or did not report enough data to estimate the small sign population.

[b]Number of signs not reported.

[c]Negligible.

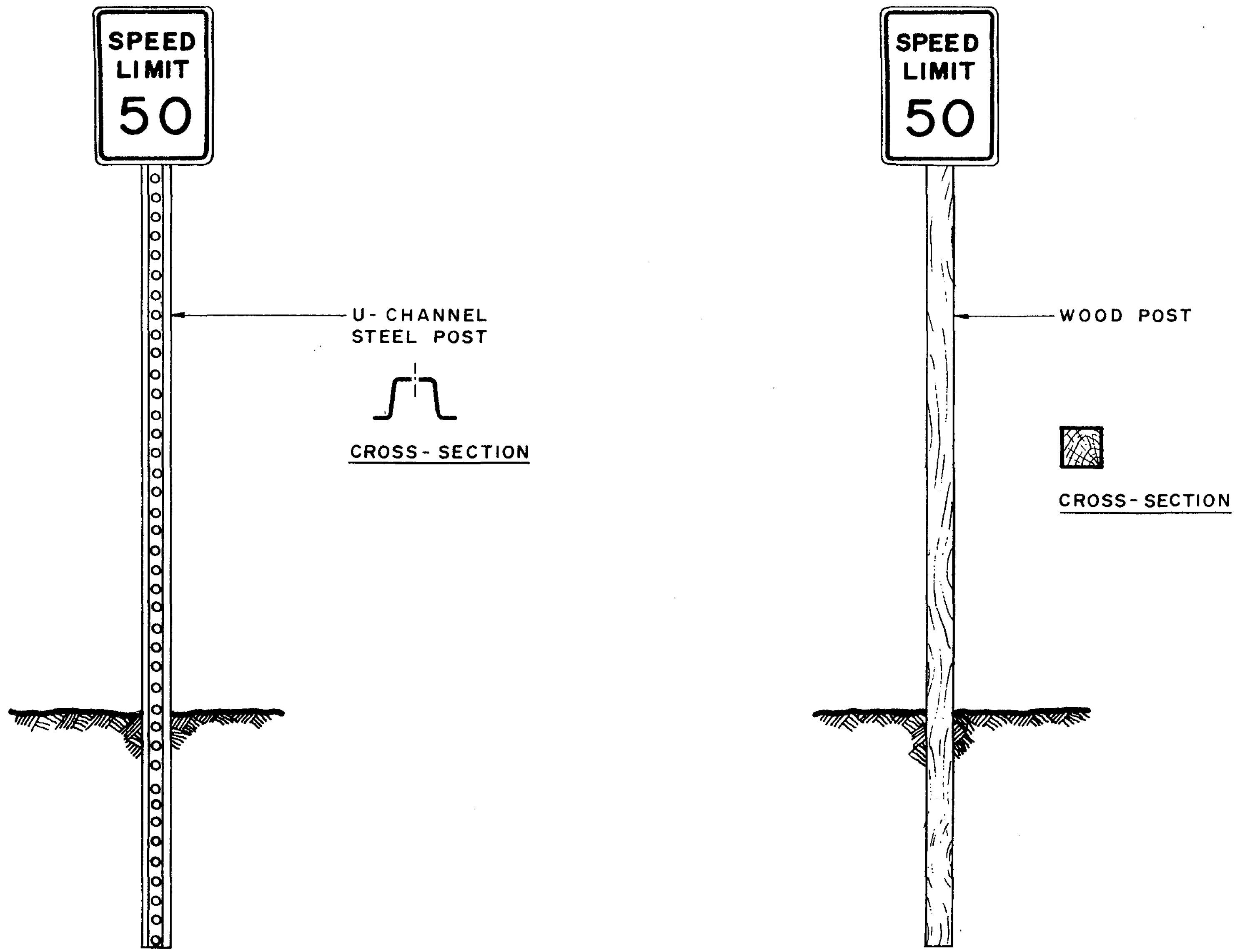



Figure III-B-1. U-Channel Post and Wood Post

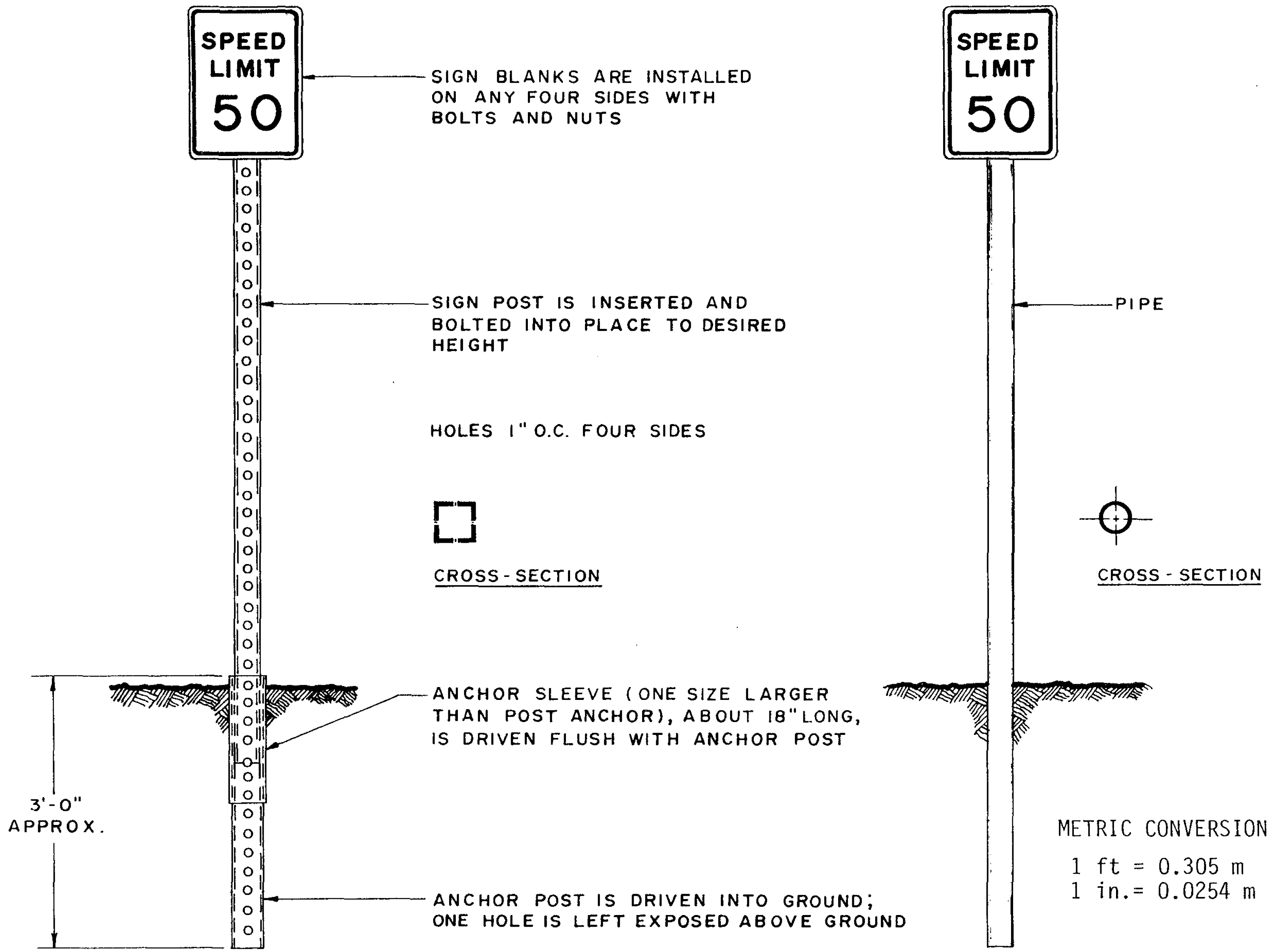



Figure III-B-2. Telescoping Tube Post and Standard Pipe Post

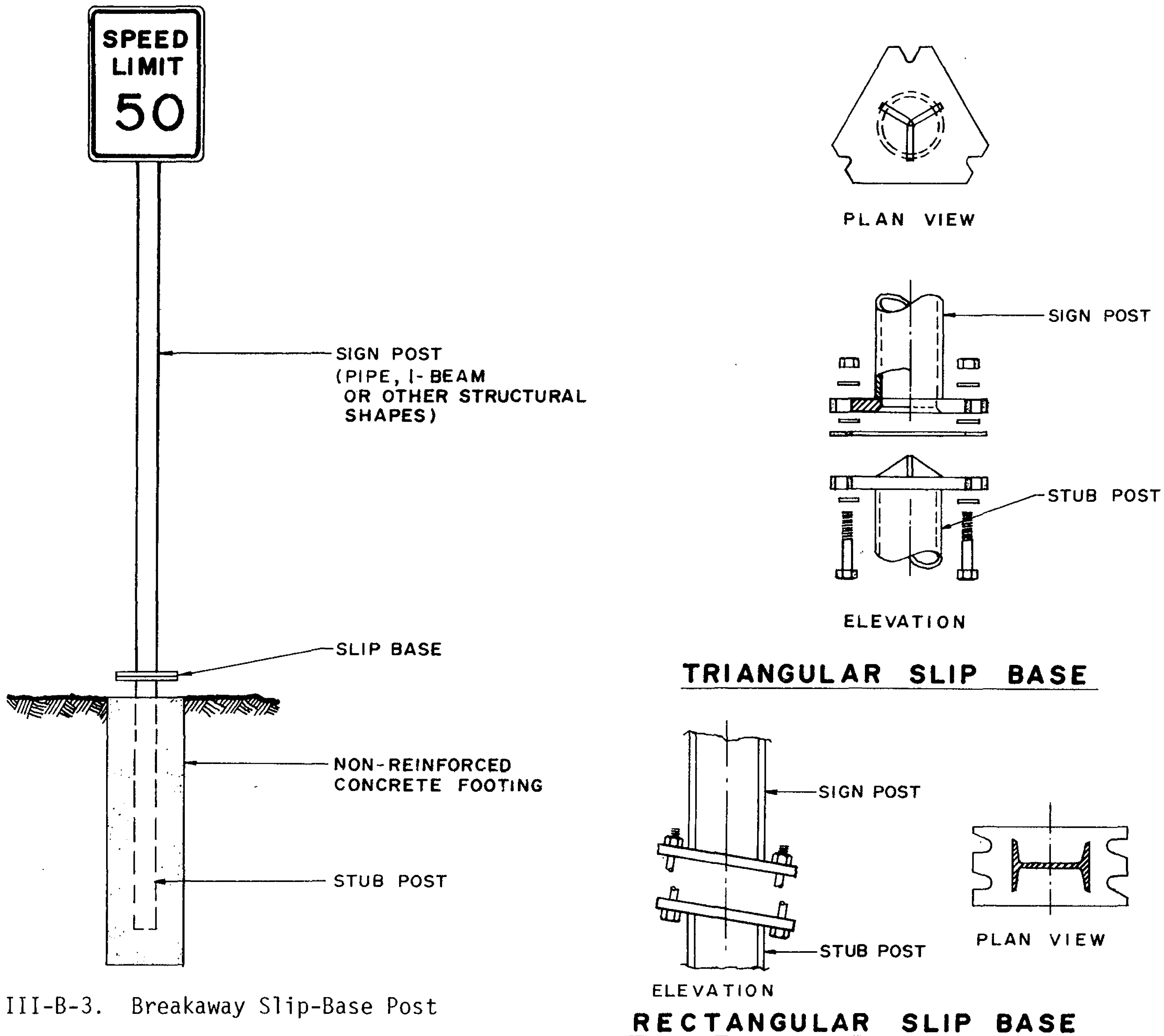



Figure III-B-3. Breakaway Slip-Base Post

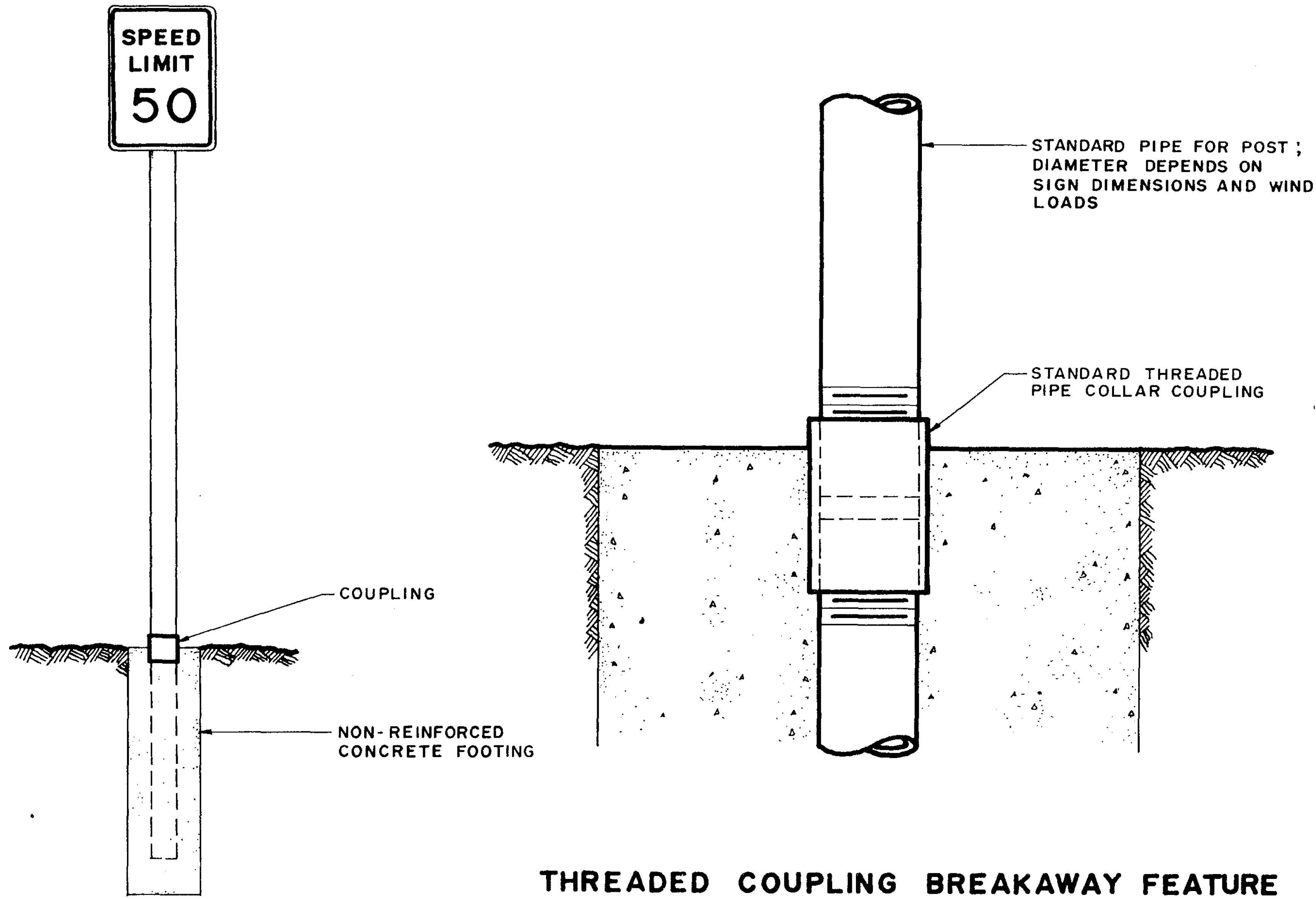



Figure III-B-4. Standard Pipe Post with Threaded Coupling Base

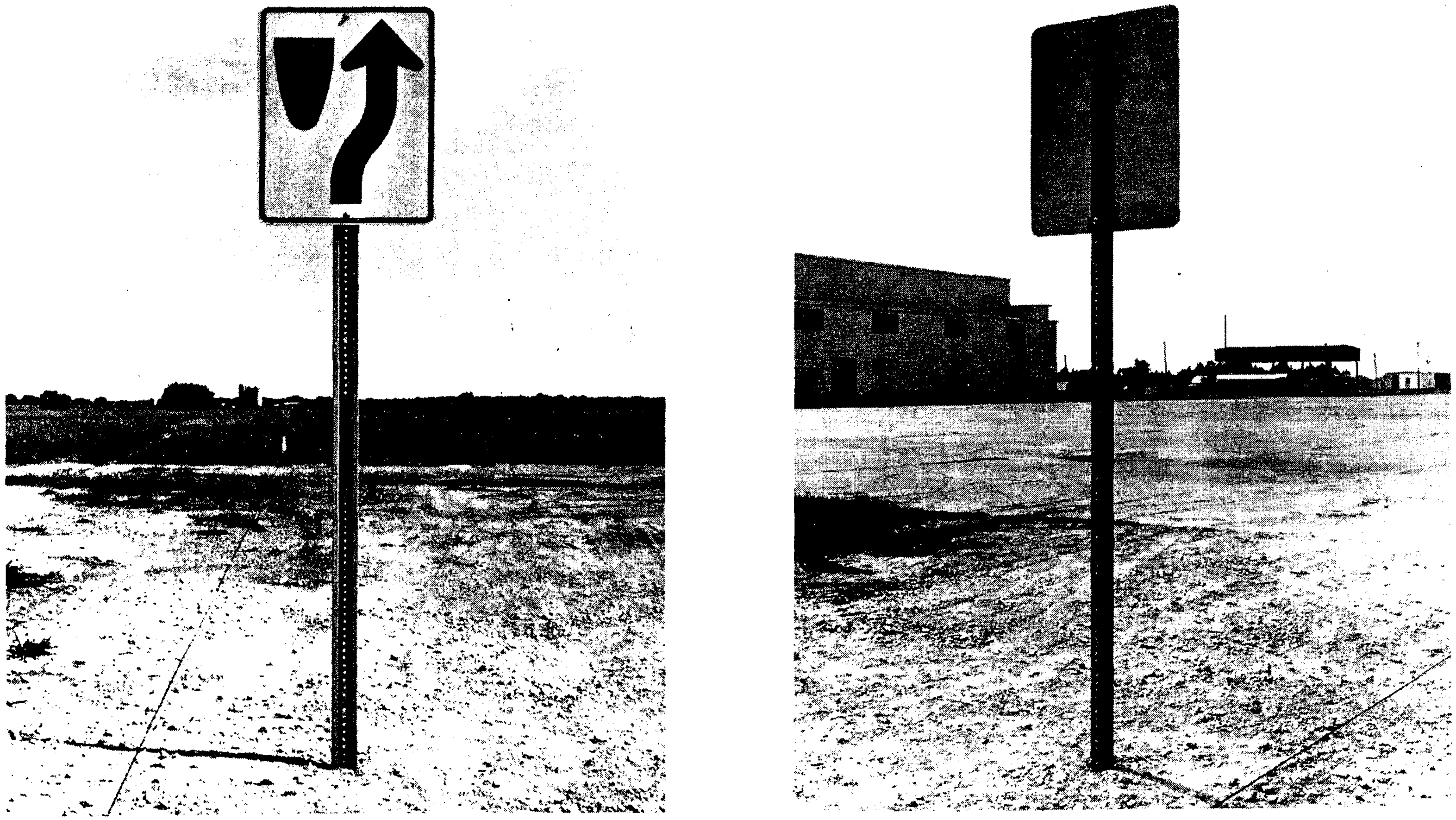


Figure III-B-5. U-Channel Post Installation.

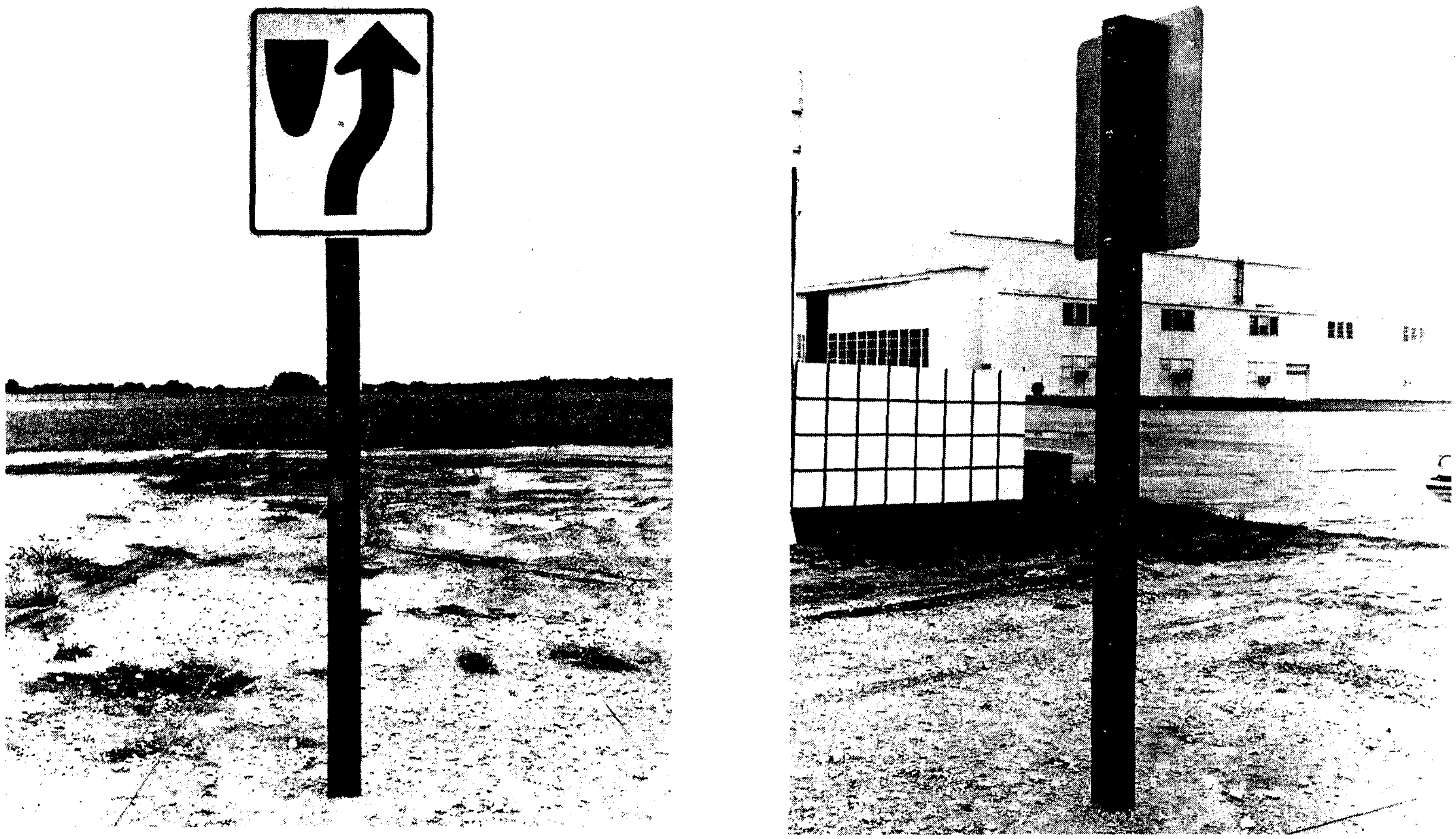


Figure III-B-6. Wood Post Installation.

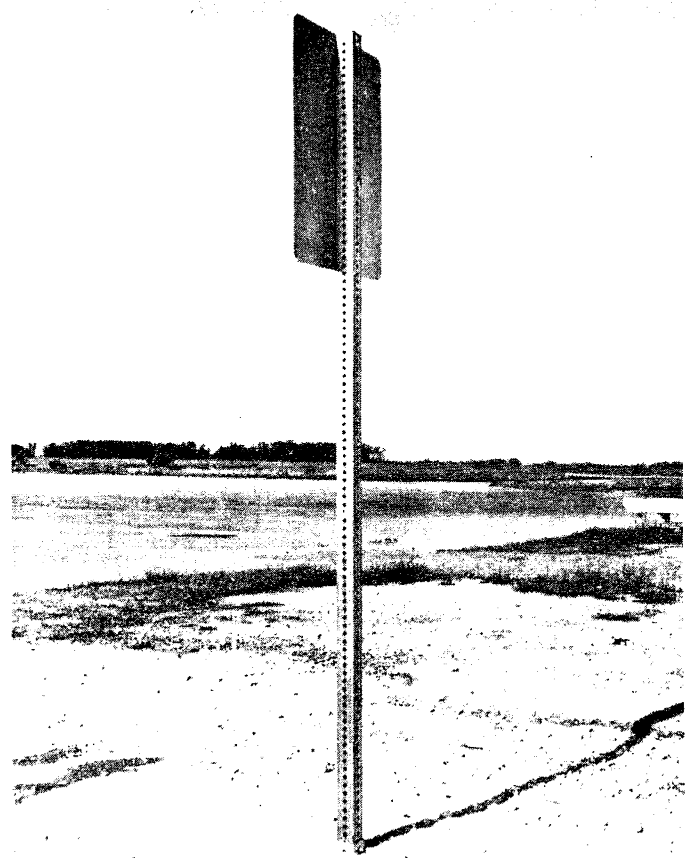



Figure III-B-7. Telescoping Tube Post Installation.

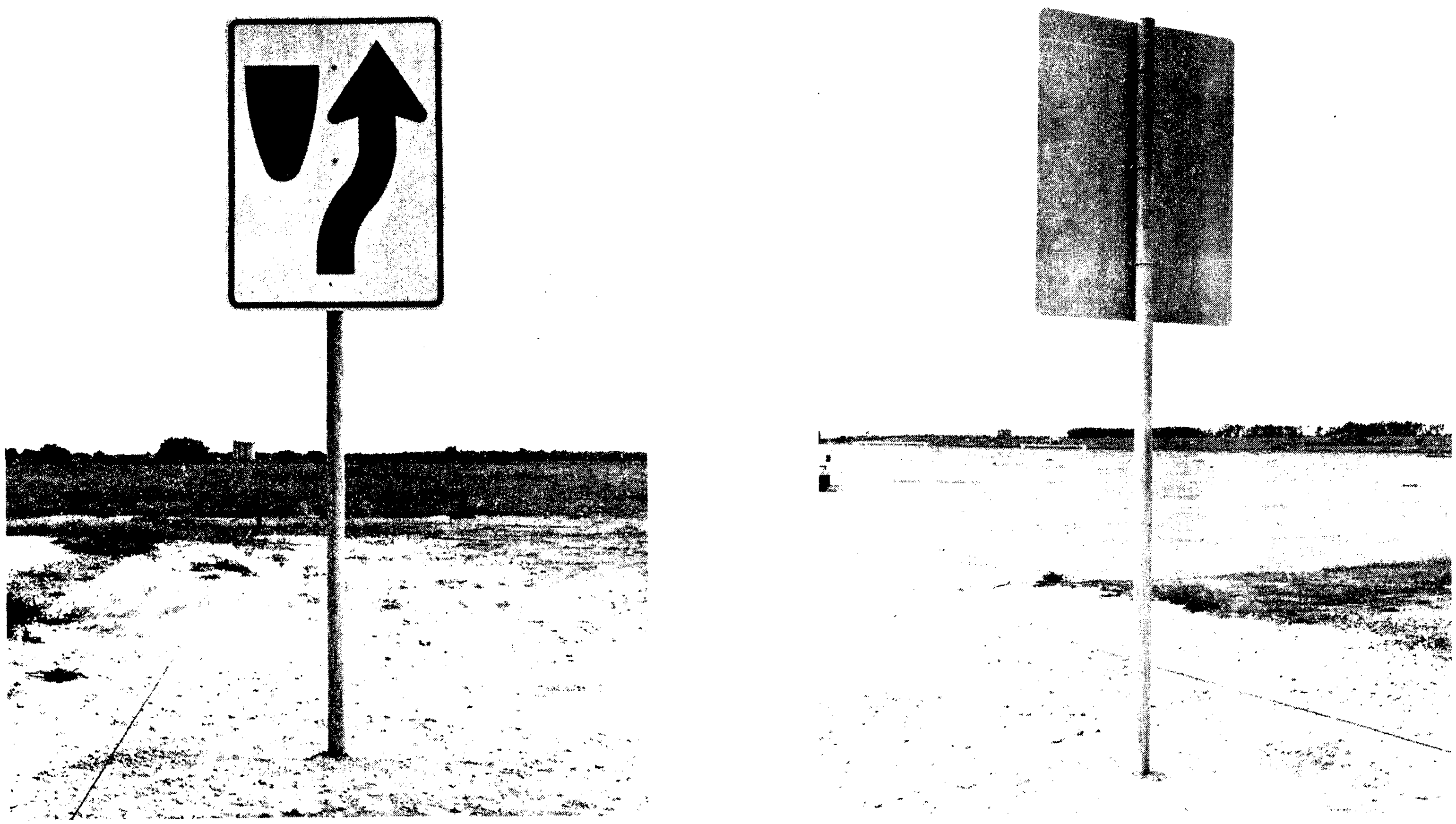


Figure III-B-8. Standard Steel Pipe Post Installation.

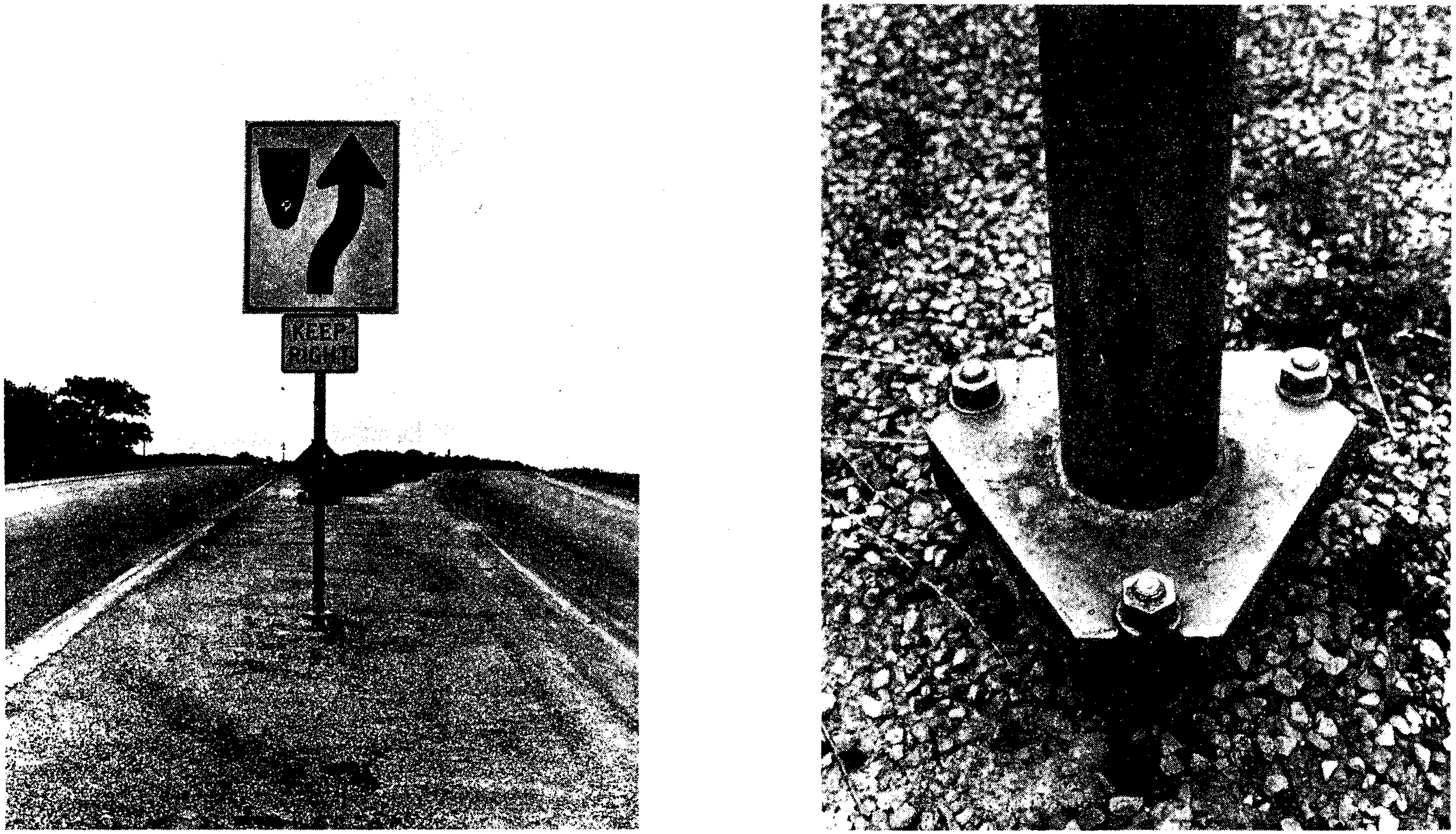



Figure III-B-9. Triangular Slip Base with Pipe Post Installation.

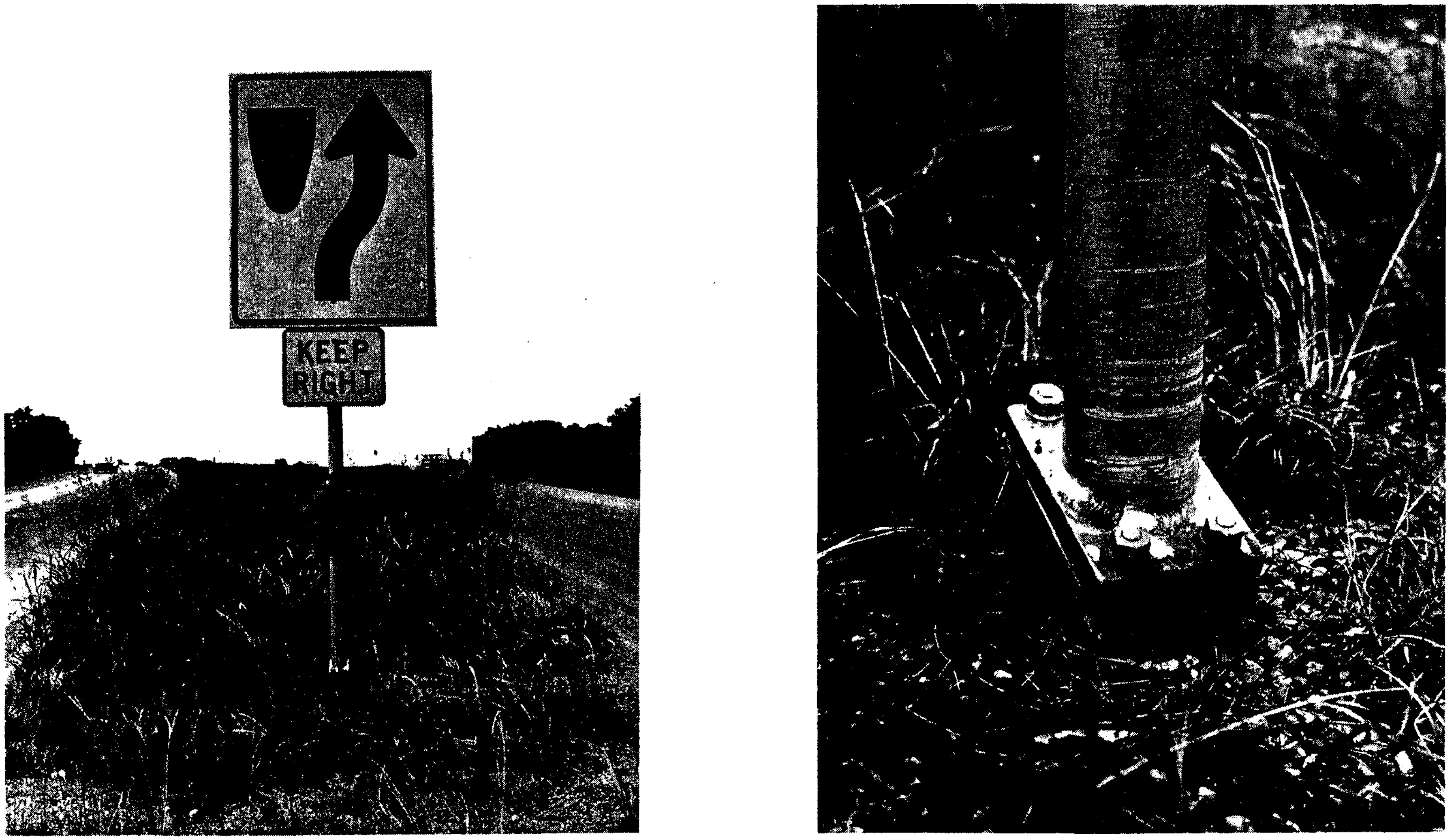



Figure III-B-10. Rectangular Slip Base with Pipe Post Installation.

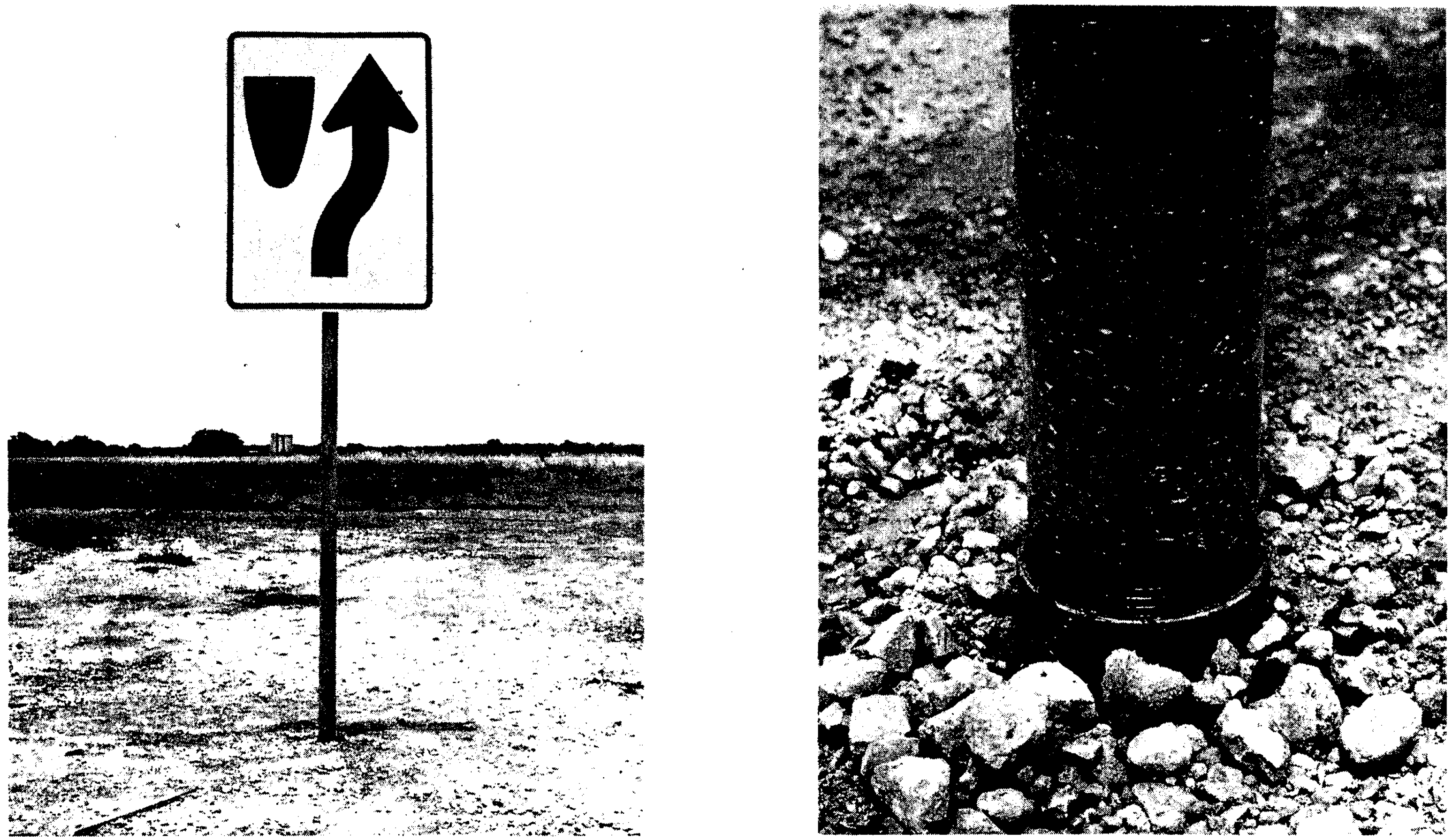


Figure III-B-11. Threaded Coupling with Standard Steel Pipe Installation.

were as shown in the table. With regard to breakaway mechanisms used with these supports, the following was found: (1) almost all of the U-post designs are driven in the soil with no breakaway mechanism; (2) about 28 percent of the wood posts are weakened at their base by drilled holes, notches or other means; (3) about 30 percent of the pipe posts have either a slip base (as illustrated in Figure III-B-4); (4) about 40 percent of the square or rectangular tubing posts have a slip base or another type of breakaway mechanism; and (5) all of the beam type posts have a slip base design. It is noted that there were apparent differences in the way the respondents interpreted the word "breakaway" and/or "breakaway mechanisms" as given in the questionnaire (see Column 5, page A-7 and Column 6, page A-8 of Appendix A). For example, one respondent indicated that the driven U-post was breakaway. The square telescoping tube design, shown in Figure III-B-2, was reported as being breakaway by many respondents and as being a "yielding" design by others. Also noteworthy is that most of the "square or rectangular tube designs" were in fact the telescoping tube design. A small percentage of rectangular tubes, without perforations, are used in combination with a slip base design (see Figure III-B-3). Further information on single support designs, such as the use of post type by regions and the post sizes used for each design type, is given in Section C3 of Appendix C.

For *multiple post installations*, given in Tables III-B-2, the U-post design again ranks as the most widely used support. Within the reporting state highway agencies, 32.4 percent of all multiple post installations (in excess of 680,000) were of the U-post design, 27.4 percent were wood (in excess of 580,000), 16.7 percent were of the beam type (in excess of 350,000), and the remainder were as shown in the table. With regard to breakaway mechanisms used with these posts, the remarks made above for a single support generally apply for multiple supports. Further information on multiple support designs, such as type used by region and post sizes used by design type, is given in Section C3 of Appendix C.

Another noteworthy finding, relevant to both single and multiple post installations, was that many agencies do not use different post types for different classes of roadways. However, several state agencies use a breakaway slip base design on freeways and a yielding or base bending design or timber posts on other roadways.

## III-C. Design, Cost, and Maintenance Data on Widely Used Sign Support Systems

A major portion of the questionnaire was aimed at determining detailed design data, cost data, and maintenance data on the three most widely used single and multiple support systems within a given agency. In some instances, responses to this part of the questionnaire were necessarily repetitious with responses to earlier questions.

A cost-effective evaluation of a sign support system requires knowledge of its initial costs, including materials and labor, an estimate of costs to repair or replace the system if hit by a vehicle, and an estimate of its normal maintenance costs and maintenance manpower requirements. Vehicle damage cost and occupant injury cost as a result of an average collision would also be desirable.

An effort was made to determine as many of the above costs as possible for the various small sign systems. As might be expected, this effort met with mixed success. Most agencies have good records of material costs, but few can break down their labor costs and maintenance requirements associated with signing, small signs in particular. To compound the problem, costs are kept in a variety of ways and in a variety of units. In some instances, which are discussed in subsequent sections, there are apparent contradictions in the reported cost and manpower data. It must also be noted that the cost data were submitted in 1976, and that costs obviously change with time. *It is therefore essential that discretion be used in interpreting the cost data.* These shortcomings notwithstanding, cost information presented herein will provide, at a minimum, a qualitative basis on which to evaluate the various support systems.

### III-C-1. Design Details

In addition to determining the basic types and sizes of supports used (discussed in Section III-B), the agencies were asked to provide details of breakaway mechanisms used (if any), methods of post or stub embedment, depth of embedment, design life of support and sign panel, and the type of sign panels used. Table III-C-1 shows the methods of embedment used as related to the post types for single support sign systems. Methods of embedment for multiple support sign systems are similar to those in Table III-C-1. Table III-C-2 shows the types of sign blank materials used with the various single support sign systems.

Table III-C-1

Method of Support Post or Stub Post Embedment
of the Most Widely Used Single Post Sign Systems, by Type of Post

| Type of Post Material/ Cross-Sectional Shape | Method of Embedment | | | | Total Systems |
|---|---|---|---|---|---|
| | Driven | Concrete | Back-Filled | Not Given | |
| | - - - - Percent of Systems - - - - | | | | (Number) |
| Steel | | | | | |
| "U" Single | 67.9 | 6.9 | 1.1 | 24.1 | (87) |
| "U" Back to Back | 66.7 | 0.0 | 0.0 | 33.3 | (3) |
| Square or Rectangular Tube | 37.2 | 31.4 | 5.7 | 25.7 | (35) |
| Round or Oval Pipe | 15.4 | 51.3 | 12.8 | 20.5 | (39) |
| Beam (I,S,W, or H) | 0.0 | 100.0 | 0.0 | 0.0 | (5) |
| Aluminum | | | | | |
| "U" Single | 100.0 | 0.0 | 0.0 | 0.0 | (1) |
| Square or Rectangular Tube | 0.0 | 100.0 | 0.0 | 0.0 | (1) |
| Round or Oval Pipe | 18.2 | 63.6 | 9.1 | 9.1 | (11) |
| Beam (I,S,W, or H) | 0.0 | 0.0 | 0.0 | 100.0 | (1) |
| Wood | | | | | |
| Square or Rectangular | 0.0 | 7.0 | 66.7 | 26.3 | (57) |
| Round | 0.0 | 0.0 | 100.0 | 0.0 | (3) |
| Plastic | | | | | |
| Pipe | 0.0 | 0.0 | 100.0 | 0.0 | (1) |

Table III-C-2

Sign Blank Materials of the Most Widely Used Single Post Sign Systems, by Type of Post

| Type of Post Material/ Cross-Sectional Shape | Sign Blank Material: Steel | Aluminum | Wood | Combination[a] | Not Given | Total Systems |
|---|---|---|---|---|---|---|
| | ------ Percent of Systems ------ | | | | | (Number) |
| Steel | | | | | | |
| "U" Single | 1.2 | 70.1 | 4.6 | 11.5 | 12.6 | (87) |
| "U" Back to Back | 0.0 | 66.7 | 0.0 | 0.0 | 33.3 | (3) |
| Square or Rect. Tube | 0.0 | 62.8 | 0.0 | 8.6 | 28.6 | (35) |
| Round or Oval Pipe | 7.6 | 69.2 | 2.6 | 10.3 | 10.3 | (39) |
| Beam (I, S, W, or H) | 0.0 | 80.0 | 0.0 | 20.0 | 0.0 | (5) |
| Aluminum | | | | | | |
| "U" Single | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | (1) |
| Square or Rect. Tube | 0.0 | 100.0 | 0.0 | 0.0 | 0.0 | (1) |
| Round or Oval Pipe | 9.1 | 90.9 | 0.0 | 0.0 | 0.0 | (11) |
| Beam (I, S, W, or H) | 0.0 | 0.0 | 0.0 | 100.0 | 0.0 | (1) |
| Wood | | | | | | |
| Square or Rectangular | 0.0 | 50.0 | 5.0 | 21.7 | 23.3 | (60) |
| Round | 0.0 | 33.4 | 33.3 | 33.3 | 0.0 | (3) |
| Plastic | | | | | | |
| Pipe | 0.0 | 0.0 | 0.0 | 100.0 | 0.0 | (1) |

[a]Primarily plywood and aluminum

Aluminum blanks are clearly the most widely used. Similar results were obtained for multiple support sign systems. With regard to design life, it was found that in most cases, the support endures considerably longer than the panel. Further design details are given in Section C4 of Appendix C.

III-C-2. Installation Data and Unit Cost Data

Each agency was asked to estimate the total cost to install a "typical" small sign installation. The respondents were asked to include all material and labor costs in the estimate. The responses are summarized in Table III-C-3 for both single and multiple post sign support systems. The percentile values are interpreted as follows: 25 percent of the respondents reported costs equal to or less than the 25th percentile value and 75 percent of the respondents reported costs equal to or less than the 75th percentile value. Also, 50 percent of the respondents reported costs equal to or less than the median value.

Several points need to be discussed with regard to these cost data. First, there is the question of what is a "typical" small, single post sign installation and a "typical" small multiple post sign installation. Unfortunately, there is no unique answer. However, based on the responses, a typical small single post sign installation has a panel area between 5 $ft^2$ (0.47 $m^2$) and about 15 $ft^2$ (1.40 $m^2$) and the sign is mounted from 5 ft (1.53 m) to 7 ft (2.14 m) above the ground. A typical small multiple post sign installation has a panel area between 15 $ft^2$ (1.40 $m^2$) and about 35 $ft^2$ (3.26 $m^2$) and the sign

Table III-C-3. Total Installation Cost of the Most Widely Used Single and Multiple Post Sign Systems for All Government Agencies Combined

| Type of Post Material/ Cross Sectional Shape | SINGLE POST SYSTEMS: Total Installation Cost: Percentile Value[a] 25th | 75th | Median[a] Value | Total Systems | MULTIPLE POST SYSTEMS: Total Installation Cost: Percentile Value[a] 25th | 75th | Median[a] Value | Total Systems |
|---|---|---|---|---|---|---|---|---|
| | - - - - - - $/Sign | - - - - - - | | (Number) | - - - - - - $/Sign | - - - - - - | | (Number) |
| Steel | | | | | | | | |
| "U" Single | 23 | 39 | 35 | (65) | 60 | 141 | 82 | (25) |
| "U" Back to Back | 0 | 0 | 0 | (0) | a | a | 139 | (1) |
| Square or Rectangular Tube | 29 | 85 | 34 | (22) | 48 | 205 | 74 | (11) |
| Round or Oval Pipe | 32 | 85 | 42 | (33) | 9 | 138 | 62 | (7) |
| Beam (I, S, W, or H) | 150 | 614 | 312 | (3) | 289 | 1106 | 660 | (17) |
| Angle (Z) | 0 | 0 | 0 | (0) | b | b | 1018 | (1) |
| Aluminum | | | | | | | | |
| "U" Single | 0 | 0 | 0 | (0) | b | b | 113 | (1) |
| Square or Rectangular Tube | b | b | 29 | (1) | b | b | 119 | (1) |
| Round or Oval Pipe | 19 | 94 | 40 | (5) | 80 | 211 | 180 | (5) |
| Wood | | | | | | | | |
| Square or Rectangular | 30 | 99 | 42 | (38) | 116 | 322 | 217 | (32) |
| Round | 39 | 76 | 49 | (3) | 168 | 478 | 350 | (3) |

[a]Percentile and median values interpreted as follows: 25 percent of the respondents reported costs equal to or less than the 25th percentile value and 75 percent of the respondents reported costs equal to or less than the 75th percentile value. Also, 50 percent of the respondents reported costs equal to or less than the median value.

[b]Insufficient data.

is mounted from 5 ft (1.53 m) to 7 ft (2.14 m) above the ground. Typically the sign blank is aluminum, although other materials are used. While the number of supports in a multiple post sign installation can range from two to four or five, it is conjectured that two to three supports are "typical". Hence, while the costs are representative of "typical" installations, variations are to be expected from agency to agency. Secondly, these costs are primarily for new roadway installations or major reconstruction projects. Much of the data was probably taken from bid costs, especially for the state agencies, and therefore represents contract costs. Thirdly, there appears to be contradictions in some of the data. For example, the total cost of a typical single steel square or rectangular tube post installation is slightly less than that of a steel "U" post installation (see Table III-C-3). However, when comparing the unit cost of the support material (see Tables III-C-4, III-C-6, and III-C-7) and the manpower required to install each system (see Table C-62) one would conclude that the cost of the "U"-post installation would be somewhat less than the tubular installation. Fourthly, higher costs for the beam type supports are due in large part to fabrication requirements of the slip base and the concrete footing used with most of these supports. There is considerably more differences in the total costs of the multiple support systems. Systems using steel U-post or steel tubing show the lower costs for both single and multiple post systems. Additional information on installation costs and installation labor requirements as related to post design, type of respondent, type of embedment, etc., are given in Section C4 of Appendix C.

Table III-C-4

Unit Cost of Typical Support Posts of the Most Widely Used Sign Systems for All Government Agencies Combined

| Type of Sign/Post | Unit Cost of Support Post: Percentile Value 25th | Percentile Value 75th | Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - - - | $/Ft. | - - - - - - | (Number) |
| Single Post Signs | | | | |
| Steel "U" Single | 0.60 | 1.00 | 0.80 | (35) |
| Steel "U" Back to Back | a | a | 1.73 | (2) |
| Steel Square or Rectangular Tube | 0.75 | 1.88 | 1.50 | (9) |
| Steel Round or Oval Pipe | 0.86 | 1.75 | 1.14 | (14) |
| Steel Beam (I, S, W, H) | a | a | 25.00 | (1) |
| Aluminum Round or Oval Pipe | a | a | 1.10 | (3) |
| Aluminum Beam (I, S, W, H) | a | a | 1.90 | (1) |
| Wood Square or Rectangular | 0.43 | 0.90 | 0.60 | (29) |
| Multiple Post Signs | | | | |
| Steel "U" Single | 0.65 | 1.00 | 0.80 | (18) |
| Steel "U" Back to Back | a | a | 1.73 | (2) |
| Steel Square or Rectangular Tube | a | a | 1.13 | (2) |
| Steel Round or Oval Pipe | 0.86 | 1.88 | 1.75 | (6) |
| Steel Beam (I, S, W, H) | 1.14 | 13.40 | 4.56 | (9) |
| Steel Angle (Z) | a | a | 10.00 | (1) |
| Aluminum Round or Oval Pipe | a | a | 1.35 | (3) |
| Wood Square or Rectangular | 0.50 | 1.60 | 0.65 | (25) |

[a] Insufficient data

METRIC CONVERSION : 1 ft = 0.305 m

Table III-C-5

Unit Cost of Support Posts by
Type of Respondent

| Type of Sign/Post/ Respondent | Unit Cost of Support Post: Percentile Value 25th | Unit Cost of Support Post: Percentile Value 75th | Unit Cost of Support Post: Median Value | Total Systems |
|---|---|---|---|---|
| | $/Ft. | | | (Number) |
| Single Post Signs | | | | |
| State Agencies | | | | |
| Steel "U" Single | 0.65 | 1.00 | 0.85 | (19) |
| Steel Round or Oval Pipe | 1.14 | 1.75 | 1.14 | (8) |
| Wood Square or Rectangular | 0.44 | 1.60 | 0.62 | (16) |
| Other Agencies | | | | |
| Steel "U" Single | 0.58 | 0.92 | 0.61 | (16) |
| Steel Round or Oval Pipe | 0.30 | 1.70 | 0.92 | (6) |
| Wood Square or Rectangular | 0.42 | 0.71 | 0.60 | (13) |
| Multiple Post Signs | | | | |
| State Agencies | | | | |
| Steel "U" Single | 0.65 | 0.85 | 0.80 | (12) |
| Wood Square or Rectangular | 0.47 | 2.40 | 0.86 | (15) |
| Other Agencies | | | | |
| Steel "U" Single | 0.61 | 1.10 | 0.97 | (6) |
| Wood Square or Rectangular | 0.50 | 0.65 | 0.60 | (10) |

METRIC CONVERSION : 1 ft = 0.305 m

Table III-C-6

Unit Prices of "U" and "X" Type Support Posts
Furnished by Suppliers

| Post Material/Shape/Size | Unit Price | | |
|---|---|---|---|
| | 100 Ft. | 1000 Ft. | 5000 Ft. |
| | --------------- | $/Ft. | ----------------- |
| Steel "U" Single | | | |
| 2.00 lbs/ft | 0.45[a] | 0.40[a] | 0.38[a,b] |
| 3.00 lbs/ft | 0.68[a] | 0.60[a] | 0.57[a,b] |
| Steel "U" Back to Back | | | |
| 6.00 lbs/ft | 1.35 | 1.21 | 1.14 |
| Aluminum "U" Single | | | |
| 3.00 lbs/ft (steel equiv.) | 1.27 | 1.18 | 1.00 |
| Aluminum "X" Single | | | |
| 2.00 lbs/ft (steel equiv.) | 1.07 | 0.99 | 0.83 |

[a]Based on painted posts. Galvanized posts are priced approximately 30 percent higher than painted posts.

[b]Average of quotes from two companies.

METRIC CONVERSION : 1 lb/ft = 1.49 kg/m

Table III-C-7

Unit Prices of Steel Tube Type Support Posts
Furnished by a Supplier

| Post Size (in.) | Wall Thickness (in.) | Unit Price[a] | |
|---|---|---|---|
| | | Non-perforated | Perforated |
| | | -------------$/Ft------------- | |
| Square Cross Section | | | |
| 1 x 1 | 0.105 | 0.50 - 0.62 | -- |
| 1.25 x 1.25 | 0.105 | 0.58 - 0.72 | -- |
| 1.5 x 1.5 | 0.105 | 0.67 - 0.84 | 0.81 - 1.01 |
| 1.75 x 1.75 | 0.105 | 0.76 - 0.95 | 0.90 - 1.12 |
| 2 x 2 | 0.105 | 0.85 - 1.06 | 0.99 - 1.24 |
| 2.25 x 2.25 | 0.105 | 0.94 - 1.17 | 1.07 - 1.34 |
| 2.5 x 2.5 | 0.105 | 1.01 - 1.27 | 1.16 - 1.45 |
| 2.5 x 2.5 | 0.135 | 1.31 - 1.64 | 1.45 - 1.81 |
| Rectangular Cross Section | | | |
| 2 x 3 | 0.105 | 1.01 - 1.27 | 1.16 - 1.45 |

[a]For galvanized finish

METRIC CONVERSION : 1 ft = 0.305 m
1 in = 0.0254 m

Typical unit costs of the most widely used support posts as given by all governmental agencies combined are shown in Table III-C-4. Except for the steel beam or angle, unit costs of support posts for single post sign systems are about the same as those for multiple sign systems. The results indicate that the wood or steel "U" posts have the lowest unit costs.

Table III-C-5 shows the support post unit costs for selected sign systems by type of respondent. The data indicates that state agencies pay more than other agencies for support posts of the same design and material. However, as a general rule the average support for small signs on state highways will be larger in size than the same type of support in the cities. Efforts to cross-tabulate the cost data by post size were inconclusive due to limited data.

Unit costs were furnished by suppliers of three of the widely used sign supports. These costs are given in Tables III-C-6 and III-C-7. Direct comparisons cannot be made between cost data provided by suppliers and governmental agencies since post sizes in the latter case vary. However, it is known that the 3 lb/ft U-post is the most widely used U-post and that the 2.0 to 2.25 inch (0.05 to 0.06 m) square perforated steel tube is the most popular tubular design. With this as a basis, the cost data as given by the governmental agencies and the supplier compares favorably in general.

Unit cost data on sign panels and miscellaneous hardware are presented in Section C4 of Appendix C.

,-3. Repair Data for Vehicle Collisions

A significant part of small sign maintenance is due to vehicle .ıpacts. Table III-C-8 shows the costs to repair widely used single post sign systems as a result of an "average" vehicle collision. With the exception of the steel beam types and the round or oval aluminum pipe, the costs are fairly uniform. Total repair costs for multiple post installations were found to be about double that of single post installations. Other data in Appendix C include percentage of total repair cost due to labor and estimated total labor to repair sign systems.

III-C-4. Normal Maintenance Data

Normal maintenance as defined herein is all activities other than those due to collision repairs needed to keep the sign installation up to standards. Table III-C-9 shows the estimated normal maintenance costs for widely used single and multiple post systems. These costs include all labor, materials, and equipment attributable to normal maintenance activities.

A very large part of sign maintenance is apparently necessitated by vandalism, as shown in Table III-C-10. On the average, these data indicate that about 30 percent of maintenance costs are due to vandalism. Also, no one post type appears to have a significant advantage over the other posts with regard to vandalism cost.

Further breakdown in maintenance costs and labor are given in Section C4 of Appendix C.

Table III-C-8

Total Cost to Repair the Most Widely Used Single Post Sign Systems, by Type of Post

| Type of Post Material/ Cross-Sectional Shape | Total Repair Cost: Percentile Value 25th | Total Repair Cost: Percentile Value 75th | Total Repair Cost: Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - - - $/Sign | | - - - - - - | (Number) |
| Steel | | | | |
| "U" Single | 20 | 40 | 28 | (51) |
| Square or Rectangular Tube | 20 | 41 | 23 | (17) |
| Round or Oval Pipe | 17 | 42 | 27 | (28) |
| Beam (I, S, W, or H) | a | a | 80 | (1) |
| Aluminum | | | | |
| Square or Rectangular Tube | a | a | 16 | (1) |
| Round or Oval Pipe | 22 | 475 | 87 | (4) |
| Wood | | | | |
| Square or Rectangular | 24 | 59 | 45 | (25) |
| Round | a | a | 30 | (1) |

[a]Insufficient data

Table III-C-9

Total Maintenance Cost of the Most Widely Used Single Post Signs, by Type of Sign and Type of Post

| Type of Sign/Post Material and Shape | Total Maintenance Cost: Percentile Value 25th | Total Maintenance Cost: Percentile Value 75th | Total Maintenance Cost: Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - - - $/Sign/Year- - - - | | | (Number) |
| Single Post Signs | | | | |
| Steel | | | | |
| "U" Single | 2 | 15 | 5 | (32) |
| "U" Back to Back | a | a | 1 | (1) |
| Square or Rectangular Tube | 4 | 14 | 10 | (13) |
| Round or Oval Pipe | 2 | 11 | 7 | (19) |
| Beam (I, S, W, H) | 12 | 12 | 12 | (2) |
| Aluminum | | | | |
| Square or Rectangular Tube | a | a | 5 | (1) |
| Round or Oval Pipe | 10 | 229 | 15 | (3) |
| Wood | | | | |
| Square or Rectangular | 5 | 24 | 10 | (23) |
| Round | 4 | 5 | 4 | (3) |
| Multiple Post Signs | | | | |
| Steel | | | | |
| "U" Single | 6 | 17 | 9 | (13) |
| "U" Back to Back | 2 | 19 | 11 | (2) |
| Square or Rectangular Tube | 4 | 26 | 13 | (7) |
| Round or Oval Pipe | 3 | 15 | 11 | (6) |
| Beam (I, S, W, H) | 22 | 42 | 31 | (11) |
| Aluminum | | | | |
| Square or Rectangular Tube | a | a | 1 | (1) |
| Round or Oval Pipe | 24 | 534 | 36 | (3) |
| Wood | | | | |
| Square or Rectangular | 8 | 15 | 11 | (23) |
| Round | 7 | 9 | 7 | (3) |

[a]Insufficient data

Table III-C-10

Percentage of Sign Maintenance Cost Due to Vandalism, by Type of Sign and Type of Post

| Type of Sign/Post Material and Shape | Percentage of Maintenance Cost | | | |
|---|---|---|---|---|
| | Percentile Value 25th | Percentile Value 75th | Median Value | Total Systems |
| | - - - - - Percent | | - - - - - | (Number) |
| Single Post Signs | | | | |
| Steel | | | | |
| "U" Single | 10 | 75 | 40 | (41) |
| "U" Back to Back | a | a | 20 | (1) |
| Square or Rectangular Tube | 13 | 71 | 23 | (11) |
| Round or Oval Pipe | 15 | 80 | 30 | (23) |
| Beam (I,S,W, or H) | 23 | 40 | 32 | (2) |
| Aluminum | | | | |
| Square or Rectangular Tube | a | a | 50 | (1) |
| Round or Oval Pipe | 15 | 71 | 30 | (3) |
| Wood | | | | |
| Square or Rectangular | 20 | 70 | 40 | (28) |
| Round | 16 | 58 | 50 | (3) |
| Multiple Post Signs | | | | |
| Steel | | | | |
| "U" Single | 22 | 50 | 30 | (17) |
| "U" Back to Back | 75 | 95 | 85 | (2) |
| Square or Rectangular Tube | 10 | 75 | 22 | (6) |
| Round or Oval Pipe | 10 | 60 | 13 | (6) |
| Beam (I,S,W, or H) | 10 | 48 | 15 | (13) |
| Aluminum | | | | |
| Square or Rectangular Tube | a | a | 10 | (1) |
| Round or Oval Pipe | 10 | 25 | 10 | (3) |
| Wood | | | | |
| Square or Rectangular | 20 | 70 | 30 | (25) |
| Round | 5 | 39 | 5 | (3) |

[a] Insufficient data.

## III-D. Comments by Agencies

Comments were solicited from the agencies in the mail survey. The respondents were asked to give any comment relevant to the questionnaire, sign support systems in general, and any ideas they may have to improve present systems. Comments were also solicited during the follow-up interviews. The following is a summary of the more substantive comments, categorized according to general comments, comments on design concepts and impact performance, and comments on costs and maintenance activities. Some comments represent the view of several agencies while others represent the view of one agency only. Numbers in parentheses following comments are the number of respondents who expressed the comment.

### III-D-1. General

- The study is timely and the results will be beneficial. (30)
- Data not kept in form requested. (10)
- Limited information available on costs and inventory. Much of information provided was "best" guess. (7)
- Questionnaire too long and time consuming. (3)
- Most cities use available poles, street lights, signals and buildings for common sign mountings. (3)
- Some of the repetitious entries in the questionnaire could have been eliminated by better form design. (1)
- Hesitant to use sole source devices. (1)

## III-D-2. Design Concepts and Impact Performance

- Many wind failures of hinge mechanism on breakaway sign supports. Question need for hinge. Hinge fails to activate about ½ of time from vehicle impacts. (7)

- Don't use anchor sleeve on telescoping steel tube design except where required for breakaway. (3)

- Vehicle impacts seldom take out more than one post in a multiple post installation. (2)

- Impact performance of slip base designs on side slopes and angle impacts is questionable. Side and angle impacts at intersections may be expected to occur. (2)

- Need tamper proof panel-to-post attachment and post-to-stub attachment. (2)

- Concerning FHWA Notice N 5040.20 (4), the embedment depth of driven posts should be variable, depending on soil conditions, and not limited to 3.5 feet (1.07 m). (2)

- Design life of treated and untreated wood post in a north central state is 35 years and 15 years, respectively. Since design life of sign installation is usually less than 15 years, need for treated post is questionable. (1)

- Had trouble removing post from anchor and sleeve of telescoping tube design after vehicle impacts. (1)

- Anchor and sleeve of telescoping steel tube design replaced about 25 percent of time after vehicle impact. (1)

- Only 6 fatalities in 5 years with all wood post signs, 4 of which were motorcycle accidents. (1)

- Galvanizing causes problems in fabricating I-beam post. "Creep" in galvanized steel causes bolt tension to relieve. Would like to use weathering steel if possible. (1)

- Suggest more extensive use of driven channel posts or similar single or in multiples to minimize need for breakaway features. (1)

- Costs will sky-rocket on us if new breakaway design is imposed upon us. (1)

- More tests are needed to check 4 inch (0.076 m) and 5 inch (0.127 m) diameter aluminum tubes to see if they provide proper yielding characteristics. (1)

-Hard caliche aggregate ground composition requires minimum of 2 lb/ft (2.97 kg/m) or better sign channel (steel posts). (1)

-Crashworthiness of urban signing not very important because the motorist has better chance of hitting non-breakaway tree than he does of hitting a sign. (1)

-Excellent non-fatal record with use of western red cedar. Material easy to work with and requires no spare parts as do other breakaway devices. (1)

-Good results from use of hollow plastic poles called flexi-posts (Barrier and delineator posts). Can be knocked over without damage to vehicle or post. (1)

-95 percent of signs are in sidewalk area behind vertical 6 inch (0.15 m) curb. (1)

-Most common post support is one that can hold a street name sign and stop sign controlling minor approach along arterial streets. (1)

-U-post installations braced because of poor soil conditions and high wind loads. (1)

-Need more emphasis on yielding or base bending supports. (1)

III-D-3. Cost and Maintenance

-At least five states report problems getting quality and delivery of wood posts. Two states report they have no such problem. One state reports problem with quality of southern pine wood posts only. (8)

-Maintenance management system now being set up will be able to provide better estimates of sign maintenance costs in future. (5)

-Much of sign replacement in large cities (maintained by state) is due to accidents or vandalism. About 45 percent of replacements in rural areas due to accidents. (4)

-Full length U-post must be driven from undesirable heights. Prefer design with drivable short anchor or stub post to which the post is easily attached. (3)

-Some rusting problems around holes of telescoping galvanized steel tube design. Signpost must be painted to prevent rusting. (3)

-In pushing back snow, snowplows bend signpost. (3)

-Maintenance forces not equipped to repair and/or replace large breakaway sign installation. (2)

-20 percent of sign maintenance money is spent for vandalism and mostly occurs on wood (Douglas Fir) supported signs. Bullet holes account for large portion of this. (2)

-Contract cost for sign installations is about twice cost state forces would incur. (1)

-Some lean-over problems with wood posts. (1)

-Pentachlorophenol treatment of wood posts caused skin irritation problems with maintenance personnel. (1)

-Atlantic coast region signs are susceptible to higher rate of deterioration due to salt. (1)

-Faces of signs deteriorate more rapidly due to snow removal. (1)

-Posts poured in place bases are not easily maintained. (1)

-Reflectorized signs have estimated life of 7-12 years depending on type reflective sheeting used, and direction sign is facing. All maintenance is performed in shop - field maintenance is kept to a minimum. Non-reflected signs have estimated life of 3-5 years. (1)

-Converted from wood posts to U-posts since latter could be installed and repaired quicker. (1)

-Use ungalvanized U-post. Paint all posts every 2 years. (1)

-Prefer U-posts over wood posts since former require much less storage area and less equipment to haul to installation sites (state has central storage and distribution location). (1)

-Wood industry needs to become more interested in quality of wood posts available. (1)

-Have cost and inventory problems with telescoping steel tube design. (1)

## III-E. New Support Systems

In surveying the current practice, several new support systems for small signs were noted. These new systems are shown in Figures III-E-1 through III-E-8. All are patented devices. Their inclusion in this report is for information only and should not be construed as an endorsement by the

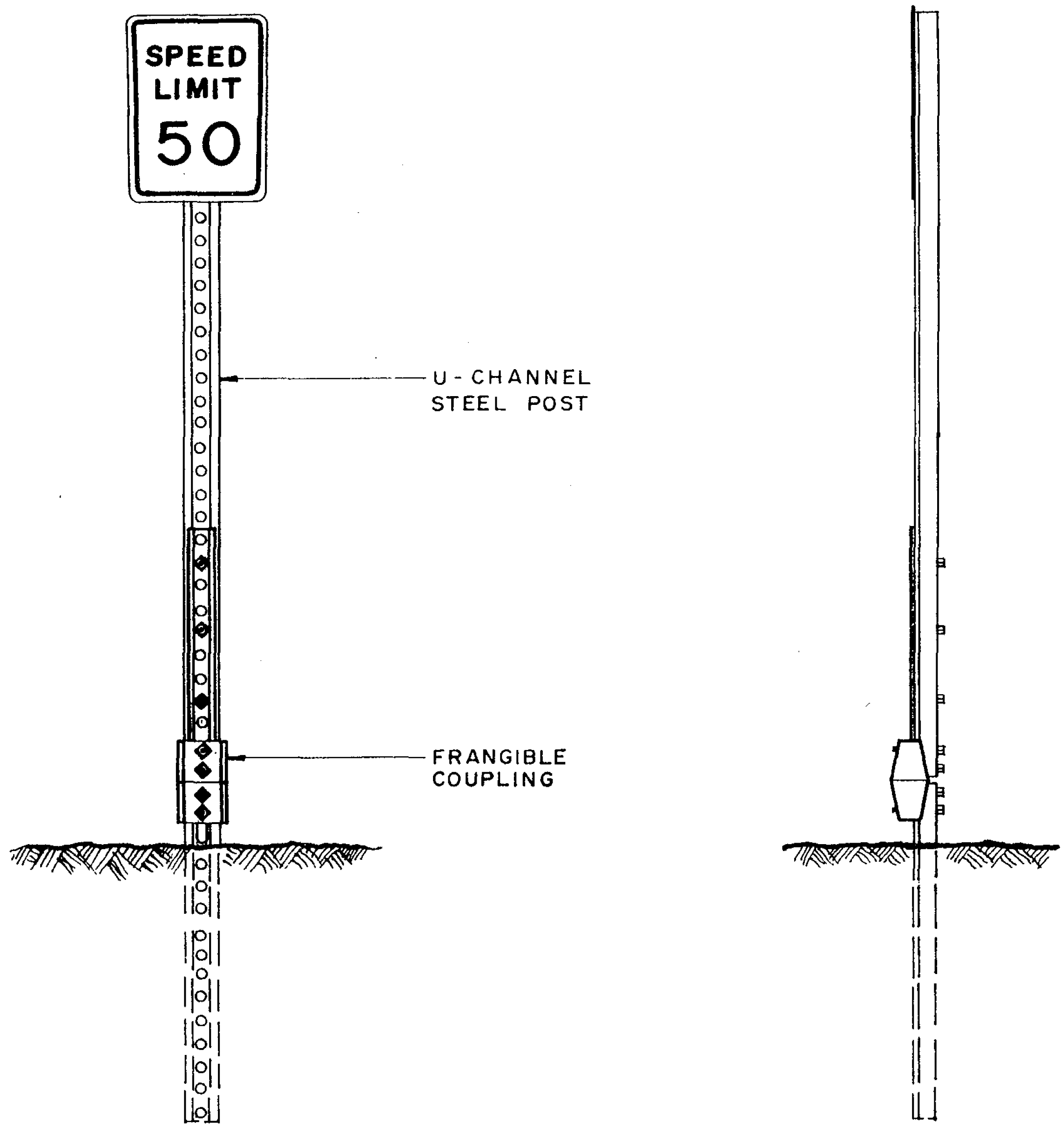



Figure III-E-1. Frangible Coupling for U-Post (19)

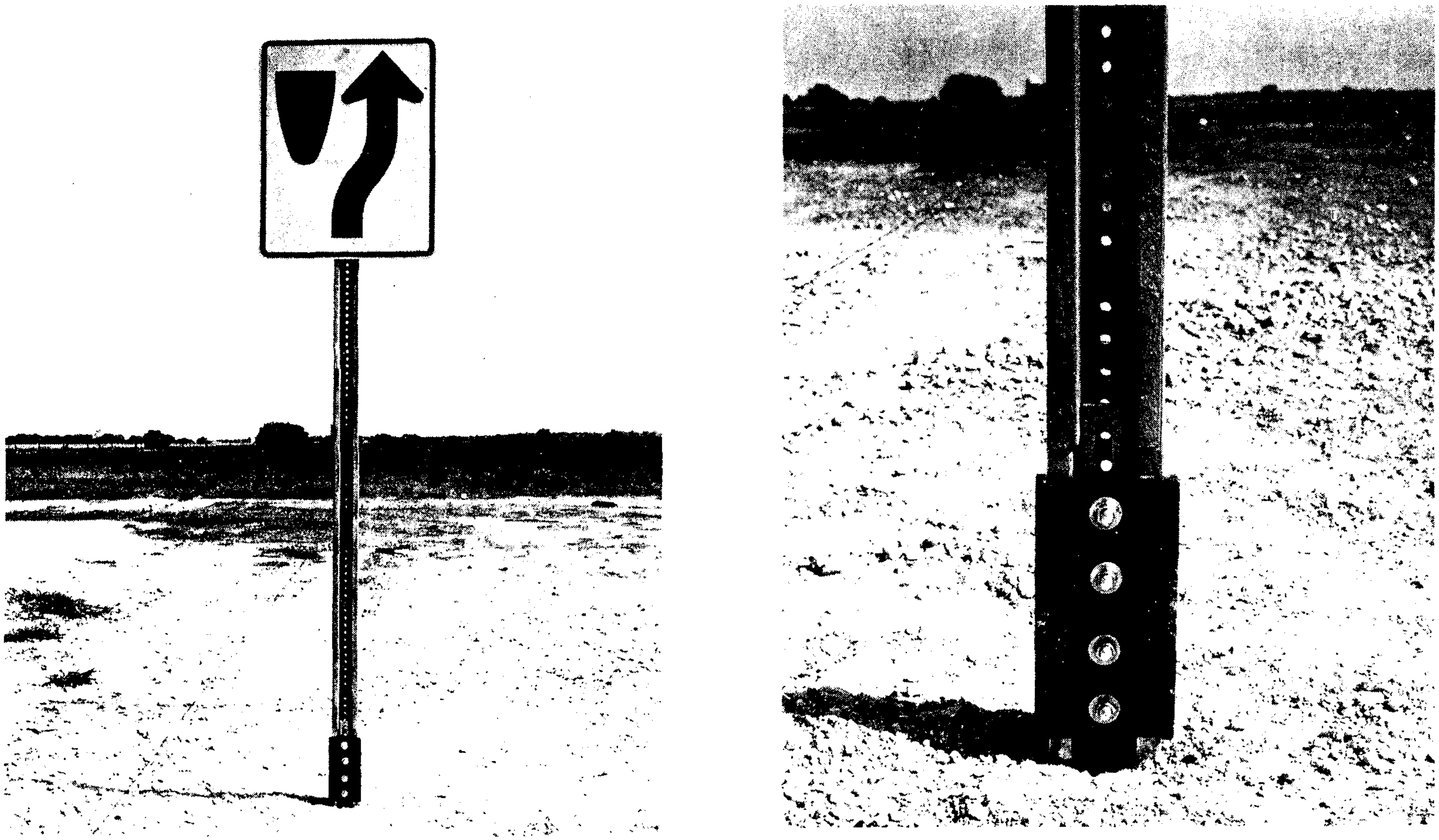


Figure III-E-2. Photos of Frangible Coupling Design (19).

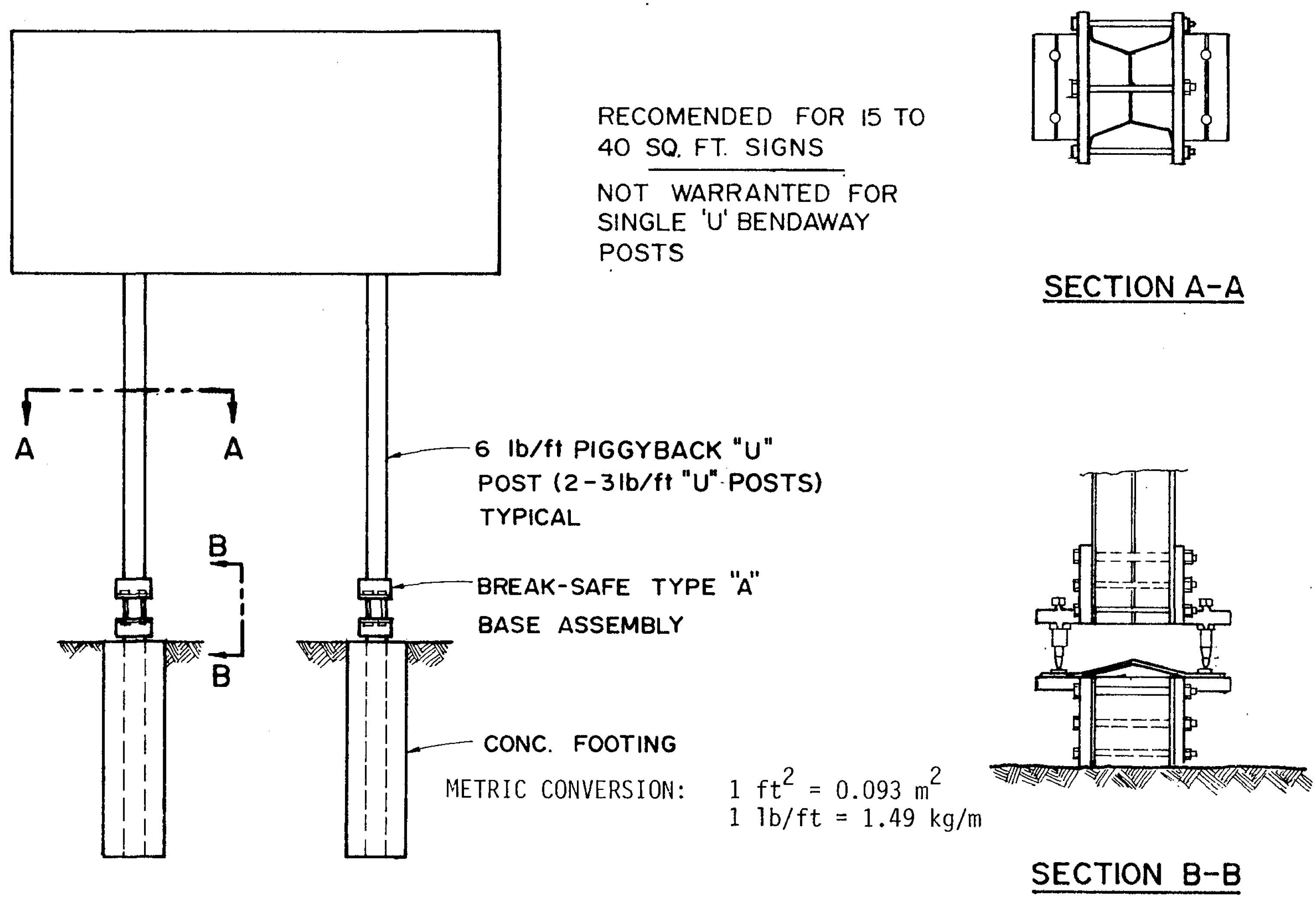



Figure III-E-3. Break-Safe Coupling (20)

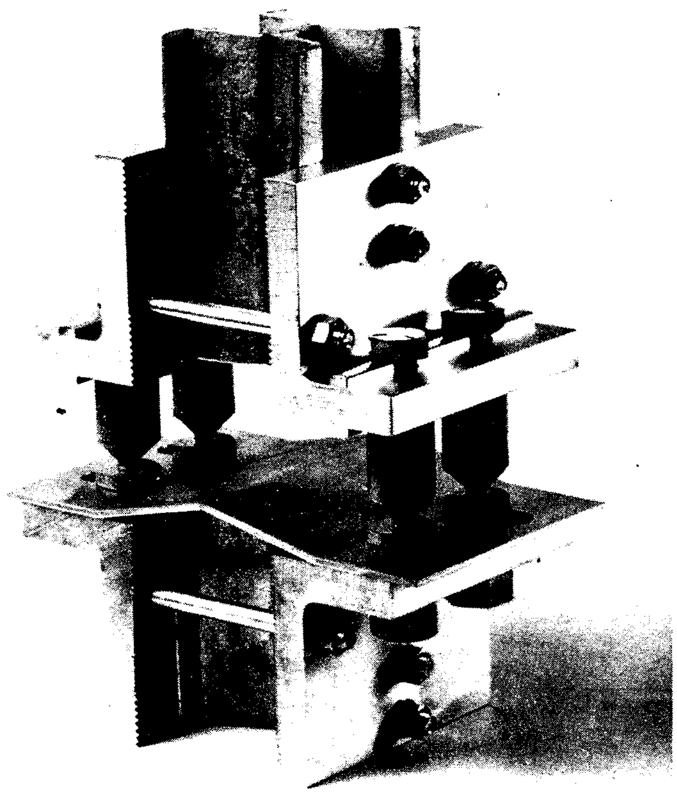


Figure III-E-4. Photo of Break-Safe Design (20).

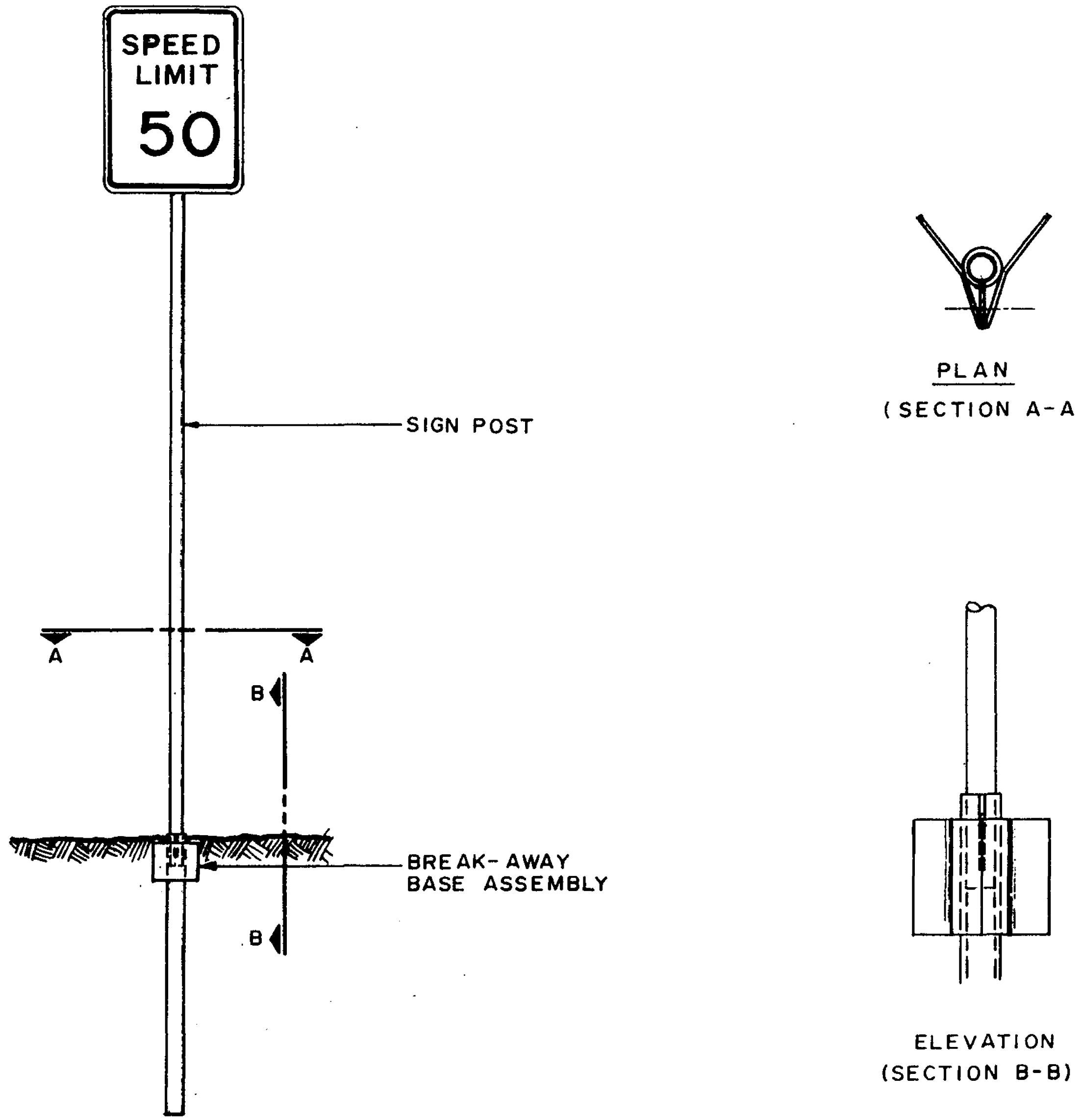



Figure III-E-5. Wedge-Lock Base for Pipe or Square Tube Posts (21)

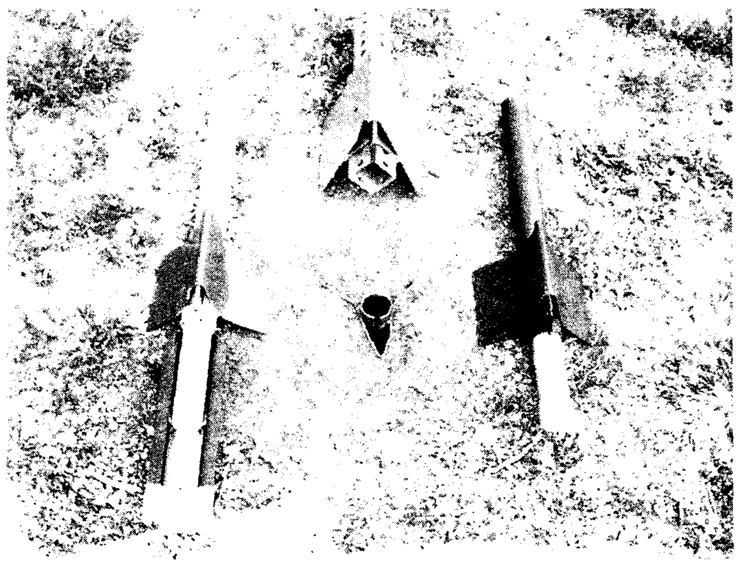


Figure III-E-6. Photo of Wedge Lock Design with Round and Square Tube Posts (21).

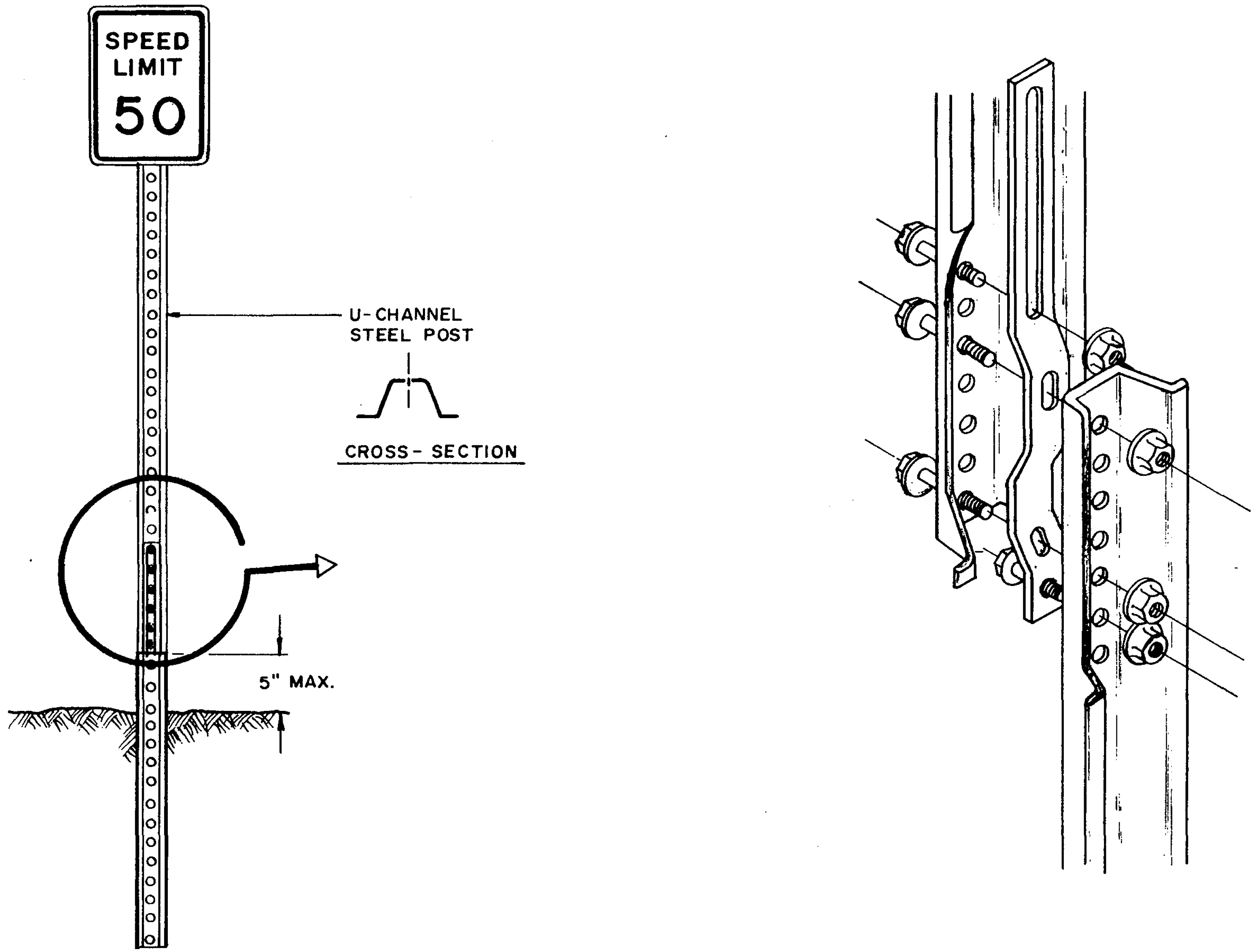



Figure III-E-7. Bolted Base Design for U-Post (5)

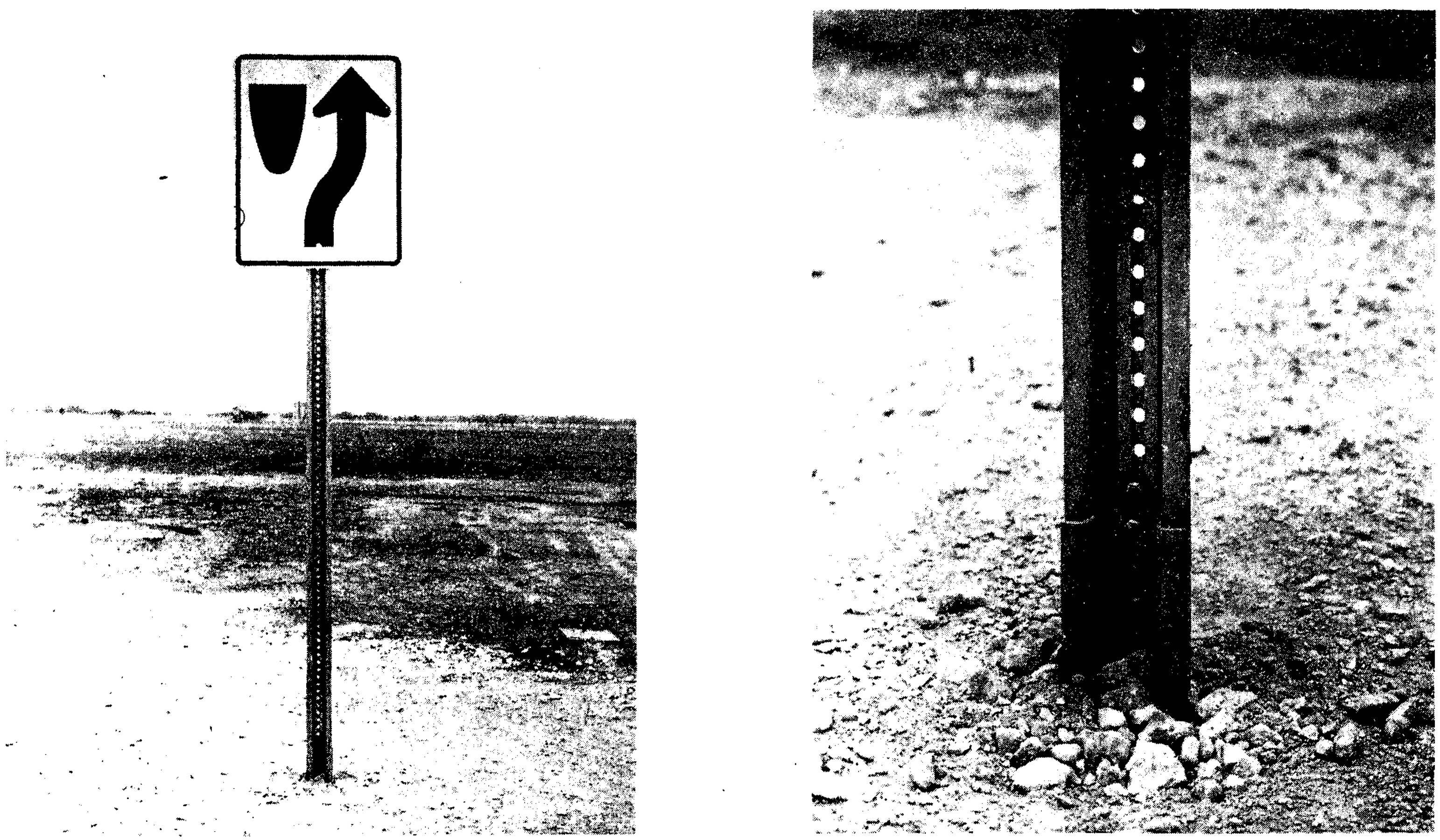


Figure III-E-8. Photos of U-Post Bolted Base Design (5)

Texas Transportation Institute or the Federal Highway Administration.

The frangible coupling shown in Figures III-E-1 and III-E-2 was designed by the General Coupling Corporation (19) specifically for the U-post. The coupling, which provides a stub-to-post connection, is designed to break if the post is impacted. Recent crash tests of a single post installation conducted within the current contract have shown that this system offers no significant hazard to motorists. It is reported to be applicable to multiple post installations also.

The design shown in Figures III-E-3 and III-E-4 was developed by Transpo Safety, Incorporated (20). Reported advantages of the coupling are that it has a simple clamp on unit and is adaptable to almost any post type. Its developer states that it may be hit from any angle with low impact resistance. It is also reported that the coupling is easily reinstalled after impact with a minimum of parts and labor. Transpo Safety recommends that this system be used with multiple post sign systems for panel areas between 15 $ft^2$ (1.40 $m^2$) and 40 $ft^2$ (3.72 $m^2$). It is not warranted for single U-post installations.

The design shown in Figures III-E-5 and III-E-6 was developed by Foresight Industries (21). Its developer states that it is a cost-effective device designed to provide a controlled break in the post upon impact. Several tests have been conducted with delineator posts (21). After impact, the "wedge lock" base was reported to be undamaged. Repairs would consist of removing the broken post stub from the base and installing a new post. Base designs are available for both pipe posts or square tubing posts.

The design shown in Figures III-E-7 and III-E-8 is under development by the Franklin Steel Company (5). The main purpose of the bolted connection is to provide a simple stub-to-post connection without compromising the static strength of the post. One objection to the use of full-length U-posts is that they must often be driven from considerable heights. If a much shorter stub can be driven and the post attached to this stub, this objection can be overcome. Also, the connection must not cause undesirable impact performance of the sign installation. Full-scale testing of this concept, conducted by the Texas Transportation Institute for the Franklin Steel Company, has shown that the concept is feasible from both an operational standpoint (normal loading conditions) and from a safety standpoint (no significant hazard to motorist).

# IV. IMPACT PERFORMANCE

When it is necessary to place a sign within the *clear zone*[1] of a traveled way, the sign and its support system should not present a hazard to the motorists. A key factor in the selection of a support system should therefore be the impact performance or crashworthiness of the candidate systems. It is the purpose of this chapter to review current impact performance criteria, present crash test results on existing sign support systems, and discuss the degree to which current support systems satisfy these criteria.

## IV-A. Criteria

At present, three sources are used to provide guidelines for measuring the hazard potential or crashworthiness of a roadside sign support. These sources and a summary of the guidelines in each are given below.

### IV-A-1. AASHTO Specification

The American Association of State Highway and Transportation Officials (AASHTO) has a specification for structural supports for highway signs, luminaires, and traffic signals (2). With regard to breakaway supports,

---

[1] Clear zone is an unobstructed area adjacent to the traveled way which is provided to enable an errant driver to return to the road or stop without the potential for a serious accident. Criteria for defining widths of clear zones are given in reference (1).

Article 1.7.2 of the specification states:

> Breakaway supports should be designed to carry loads as provided in *Section 2*. Dynamic performance under automobile impact must also be considered. This is best accomplished by full-scale dynamic testing, sometimes coupled with model studies or computer simulations. Satisfactory dynamic performance is indicated when the maximum change in momentum for a standard 2250 pound (1020kg) vehicle, or its equivalent, striking a breakaway support at speeds from 20 mph to 60 mph (32 kmph to 97 kmph) does not exceed 1100 pound-seconds (4893 N-sec), but desirably does not exceed 750 pound-seconds (3336 N-sec).
>
> All breakaway supports in multiple support sign structures shall be considered as acting together to cause a change in impact vehicle velocity unless each support is designed to independently release from the sign panel, the sign panel has sufficient torsional strength to insure this release and the clear distance between supports is eight feet (2.44m) or greater.

Comments in the specifications regarding the time duration over which the change in momentum is computed are as follows:

> The time required to force a breakaway support out of the way of an impacting vehicle is significant in determining the importance of the total change in vehicle momentum during the impact event. For the impact conditions given in the specifications, measuring the vehicle change in momentum as the highest change in momentum over any 150 msec. (possibly 200 msec.) period of an impact event should give an adequate indication of the acceptability of the support.

The specification defines "breakaway supports" as follows: "The term breakaway support as used herein refers to all types of signs, luminaire and traffic signal supports that are designed to be safely displaced under vehicle impacts, whether the release mechanism is a slip plane, plastic hinges, fracture elements or a combination of these."

IV-A-2. NCHRP Report No. 153

National Cooperative Highway Research Program (NCHRP) Report No. 153 (3) was written to promote uniform testing and evaluation of roadside appurtenances. Recommendations are made with regard to the testing facility, test article, test vehicle, test conditions, data acquisition systems, and performance evaluation. Evaluation criteria for breakaway or yielding sign supports are subdivided into three categories, as follows (3):

| | | |
|---|---|---|
| I. | Structural Adequacy: | The test article shall not pocket or snag the vehicle causing abrupt deceleration or spinout or shall not cause the vehicle to rollover. The vehicle shall remain upright during and after impact although moderate roll and pitching is acceptable. There shall be no loose elements, fragments or other debris that could penetrate the passenger compartment or present undue hazard to other traffic. |
| II. | Impact Severity: | Maximum momentum change of the vehicle during impact shall be 1100 lb-s (4892 Ns). This is required for Test 1 only; preferably it is applicable to both Tests 1 and 2. |
| III. | Vehicle Trajectory Hazard: | After impact, the vehicle trajectory and final stopping position shall intrude a minimum distance into adjacent traffic lanes. |

As mentioned in II on the preceding page, two full-scale crash tests are recommended to evaluate the impact severity. Test 1 involves a 4500 lb (2040 kg) vehicle impacting at 40 mph (64.4 km/h) and Test 2 involves a 2250 lb (1020 kg) vehicle impacting at 20 mph (32.2 km/h). Commentary on these two tests follows (3).

> The purposes of conducting Test 1 are to evaluate the maximum deceleration or velocity change of the vehicle and to evaluate the trajectory and final resting place of any detached elements (such as luminaire poles) with respect to other traffic. Test 1 has been used for several years, and a significant number of test results have been accumulated.
>
> Test 2 is a new test, and it is unknown whether current-generation breakaway or yielding supports can meet the 1,100-lb-sec (4,892 Ns) momentum change criterion for the specified impact conditions. For this reason, the objective of the test is to demonstrate that the support will activate or fracture in the designed manner. Although the 1,100 lb-sec (4,892 Ns) momentum change criterion is not presently applicable to Test 2, it is a worthy design goal for breakaway and yielding supports; the momentum change should be reported.[2]

With regard to the time duration for which the change in momentum is computed, the report states (3):

> For yielding supports (such as base-bending signs) change in vehicle momentum to be used in the acceptance criteria of this section shall be computed on the basis of time integration of the vehicle deceleration signal over a "duration of the event". This duration shall be defined as the lesser of the following: (1) time between incipient contact and loss of contact between the vehicle and the yielding support, or (2) the time for a free missile to travel a distance of 24 in. starting from rest with the same magnitude of vehicle deceleration.

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[2]These impact performance criteria have been superseded by the AASHTO criteria (2) as given in the previous section.

IV-A-3. FHWA Notice N 5040.20

The Federal Highway Administration (FHWA) of the Department of Transportation issued a notice on July 14, 1976 regarding structural supports for highway signs, luminaires, and traffic signals (4). The purpose of the notice was to:

a. Institute application of the AASHTO specifications (2); and,

b. to transmit suggested guidelines for application of the breakaway requirements of the subject specifications.

Of special interest are the guidelines regarding timber sign supports and base bending sign supports. These are as follows (4):

> Timber Sign Supports - Timber breakaway supports are quite feasible. However, it is beleived that there is no past testing that would qualify designs under the new AASHTO specification. However, available information suggests that soil mounted timber designs (without concrete foundation collars or soil bearing plates) would be acceptable if the posts have uniform cross-sections and if, in an 8-foot (2.44m) path, there is or are:
>
> A single post with an elastic section modulus no greater than 24 $in^3$ ($391 \times 10^{-6}$ $m^3$)(full dimension 4" x 6" (.10m x .15m) post).
>
> Two posts, each with an elastic section modulus no greater than 18 $in^3$ ($293 \times 10^{-6}$ $m^3$)(full dimension 3" x 6" (.08m x .15m) or 4" x 5" (.10m x .13m) posts)
>
> Three posts, each with an elastic section modulus no greater than 14 $in^3$ ($228 \times 10^{-6}$ $m^3$)(full dimension 3" x 5" (.08m x .13m) or 4" x 4" (.10m x .10m) posts).
>
> Other designs should be qualified through dynamic testing.
>
> Base Bending (Yielding) Sign Supports - Performance of this type sign support is probably the most difficult to predict. For this reason an attempt has been made to be conservative in developing the following recommendation.

For this type structure, unless acceptability is demonstrated through testing and/or an approved analytical method, of which there is none today, posts should be set in soil to a depth no greater than 3.5 feet (1.01 m, without concrete foundation collars, soil bearing plates, or anchors) and, within a 8-foot (2.44m) path, the <u>plastic</u> section moduli should not exceed:

For a single post, 1.3 $in^3$ ($21.1 \times 10^6$ $m^3$)

For two posts, each .7 $in^3$ ($11.4 \times 10^6$ $m^3$)

For three posts, each .4 $in^3$ ($6.5 \times 10^6$ $m^3$)

These moduli recommendations are based on an assumed typical ultimate tensile strength of the material in the posts equal to 110 ksi ($758.42 \times 10^6$ Pa). For materials with another typical ultimate strength the sum of the section moduli can be adjusted by multiplying the given section moduli by an amount equal to 110 ksi ($758.42 \times 10^6$ Pa) divided by the typical ultimate strength of the material in ksi (Pa). [3]

## IV-B. Crash Tests

A survey was made of crash test data on roadside sign supports, primarily those used to support the smaller roadside signs. The results of that survey are given in Appendix B. The data are categorized according to post type as follows:

(1) Steel U-Post - Table B1

(2) Aluminum U-Post - Table B2

(3) Wood Post - Table B3

(4) Steel Pipe Post - Table B4

(5) Steel I-Beam - Table B5

(6) Steel Tubing, Telescoping Design - Table B6

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[3] Recent full-scale crash tests, conducted under this contract, have shown that these plastic section moduli are too large for certain types of posts. Consultation with appropriate agencies should be made prior to selection of posts based on these criteria.

Reference should be made to Figures III-B-1 through III-B-3 for illustrations of these post shapes.

It can be seen that some of the widely used support posts have been tested extensively while others have received little or no crash test evaluation. The degree to which these tests satisfy the criteria given in Sections IV-A-1 and IV-A-2 is discussed in Section IV-D.

IV-C. Section Properties of Base Bending and Timber Supports

The criteria given in Section IV-A-3 identifies limiting *plastic section moduli* for base bending sign supports, i.e., those with no built-in breakaway features. It also gives limiting *elastic section moduli* of timber posts. Table IV-C-1 lists these moduli for typical base bending support systems. Also shown are limiting values of the plastic section modulus and the number of posts permitted within an 8-foot (2.44m) path.

With regard to the U-post design, three suppliers are referenced in Table IV-C-1, two for the steel (5, 6) and one for the aluminum (7). Typical cross sections of the designs are given in Appendix D. It should not be misconstrued that these are the only suppliers of U-posts since there are others. However, posts supplied by these companies are representative of the majority of U-posts used in the United States.

It is noted that the perforated square steel tubing is often used in a telescoped design, as illustrated in Figure III-B-2 of Chapter III. It was developed by the Unistrut Corporation (8). There is no clear distinction as to how this telescoped design should be classified with regard to its impact characteristics. In one respect, it has a

# TABLE IV-C-1. PLASTIC SECTION MODULI OF TYPICAL BASE BENDING SUPPORTS FOR SMALL SIGNS

| POST TYPE | SIZE | PLASTIC SECTION MODULUS (IN³) | LIMITING PLASTIC SECTION MODULUS (IN³)[g] | | | NUMBER OF POSTS PERMITTED IN 8-FOOT PATH[g] |
|---|---|---|---|---|---|---|
| | | | 1-POST | 2-POST | 3-POST | |
| Steel U-Post | 2 lb/ft | 0.25[a] 0.25[b] | 1.3 | 0.7 | 0.4 | 3[a] 3[b] |
| | 3 lb/ft | 0.49[a] 0.53[b] | 1.3 | 0.7 | 0.4 | 2[a] 2[b] |
| | 4 lb/ft | 0.71[a] (c) | 1.3 | 0.7 | 0.4 | 2[a] - |
| | 6 lb/ft[d] | 1.55[a,d] 1.89[b,d] | 1.3 | 0.7 | 0.4 | 0 0 |
| | 8 lb/ft[e] | 2.07[a,e] (c) | 1.3 | 0.7 | 0.4 | 0 - |
| Aluminum U-Post[f] | 2X | 0.45 | 3.41 | 1.83 | 1.05 | 3 |
| | 3X | 1.06 | 3.41 | 1.83 | 1.05 | 3 |
| | 4X | 1.27 | 3.41 | 1.83 | 1.05 | 2 |
| | 6 | 3.03 | 3.41 | 1.83 | 1.05 | 1 |
| | 8 | 4.20 | 3.41 | 1.83 | 1.05 | 0 |
| Standard Steel Pipe | 2 in. ϕ | 0.76 | 2.38[h] | 1.28[h] | 0.73[h] | 3 |
| | 2½ in. ϕ | 1.45 | 2.38[h] | 1.28[h] | 0.73[h] | 1 |
| | 3 in. ϕ | 2.33 | 2.38[h] | 1.28[h] | 0.73[h] | 1 |
| | 3½ in. ϕ | 3.22 | 2.38[h] | 1.28[h] | 0.73[h] | 0 |
| | 4 in. ϕ | 4.31 | 2.38[h] | 1.28[h] | 0.73[h] | 0 |
| Standard Aluminum Pipe | 2 in. ϕ | 0.76 | 3.41[i] | 1.83[i] | 1.05[i] | 3 |
| | 2½ in. ϕ | 1.45 | 3.41[i] | 1.83[i] | 1.05[i] | 2 |
| | 3 in. ϕ | 2.33 | 3.41[i] | 1.83[i] | 1.05[i] | 1 |
| | 3½ in. ϕ | 3.22 | 3.41[i] | 1.83[i] | 1.05[i] | 1 |
| | 4 in. ϕ | 4.31 | 3.41[i] | 1.83[i] | 1.05[i] | 0 |
| Square Steel Tubing (No Perforations) | 1 in x 1 in[k] | 0.12 | 2.6[l] | 1.4[l] | 0.8[l] | 3 |
| | 1½ in x 1½ in[k] | 0.30 | 2.6[l] | 1.4[l] | 0.8[l] | 3 |
| | 2 in x 2 in[k] | 0.55 | 2.6[l] | 1.4[l] | 0.8[l] | 3 |
| | 2½ in x 2½ in[j] | 1.11 | 2.6[l] | 1.4[l] | 0.8[l] | 2 |
| Square Steel Tubing (Perforated by 7/16 in.ϕ holes on four sides 1 in. o.c.) | 1½ in x 1½ in[k] | 0.22 | 2.6 | 1.4 | 0.8 | 3 |
| | 2 in x 2 in[k] | 0.45 | 2.6 | 1.4 | 0.8 | 3 |
| | 2½ in x 2½ in[j] | 0.95 | 2.6 | 1.4 | 0.8 | 2 |

[a]Data for Franklin Steel Company U-Post (5).

[b]Data for Armco Steel Corporation U-Post (6).

[c]Not produced by Armco Steel Corporation.

[d]Two 3 lb/ft sections bolted together back-to-back. Plastic section modulus based on monolithic cross-section.

[e]Two 4 lb/ft sections bolted together back-to-back. Plastic section modulus based on monolithic cross-section.

[f]Size designations and moduli furnished by Magnode Products Inc. (7) Posts are designed to provide bending strength about axis parallel to sign face equivalent to corresponding steel U-posts. Designating numbers represent weight per foot of corresponding steel U-posts. Limiting moduli based on 6061-T6 aluminum with ultimate strength of 42 ksi.

[g]As per criteria in Section IV-A-3. See footnote 3 of Chapter IV.

[h]Based on A53-69a steel with ultimate strength of 60 ksi.

[i]Based on 6061-T6 aluminum with ultimate strength of 42 ksi.

[j]Wall thickness of 0.135 in.

[k]Wall thickness of 0.105 in.

[l]Based on ultimate strength of 55 ksi.

METRIC CONVERSIONS:

1 lb/ft = 1.49 kg/m

1 inch = 0.0254 m

1 ksi = $6.89 \times 10^6$ Pa

1 ft = 0.305 m

breakaway feature in that the post is designed to break at the groundline due to the stiffening effects of the anchor post and sleeve. However, the failure mode is due primarily to bending of the post.

An elastic modulus is used to evaluate wood posts. As such, the criterion is a function of the cross-sectional properties of the post only and independent of its material properties. Table IV-C-2 summarizes the limiting conditions for wood posts used to support small signs. As noted, the data in Table IV-C-2 is based on posts without weakened sections. Holes are often drilled at the base of larger wood posts to reduce their impact resistance. Notches or weakened planes are also used for the same purpose.

IV-D. Impact Performance of Typical Supports

An effort was made to evaluate the currently used supports for small signs in terms of current safety criteria. The results of this evaluation are shown in Table IV-D-1 for single supports and in Tables IV-D-2 and IV-D-3 for two supports.

In reviewing these data it is apparent that many of the currently used supports cannot be evaluated in terms of either the momentum criteria or the trajectory criteria since they have never been evaluated by full-scale crash tests. Of those that have been crash tested, the results were not well documented in several cases, or the tests did not conform to present guidelines (2, 3). Prior to these guidelines, it was commonplace to use standard size automobiles for crash vehicles. In view of the increasing number of smaller vehicles

TABLE IV-C-2. Elastic Section Moduli of Typical Wood Supports for Small Signs[a]

| NOMINAL DIMENSION[c] | ELASTIC SECTION MODULUS ($IN^3$) | | LIMITING ELASTIC SECTION MODULUS ($IN^3$)[b] | | | NUMBER OF POSTS PERMITTED IN 8-FOOT PATH[b] |
|---|---|---|---|---|---|---|
| | NOMINAL DIMENSION | DRESSED | 1-POST | 2-POST | 3-POST | |
| 4 in x 4 in | 10.7 | 7.1 | 24.0 | 18.0 | 14.0 | 3[e] |
| 4 in x 6 in | 24.0 | 17.6 | 24.0 | 18.0 | 14.0 | 2[e] |
| 6 in x 6 in | 36.0 | 27.7 | 24.0 | 18.0 | 14.0 | 0[e] |
| 6 in x 8 in | 64.0 | 51.6 | 24.0 | 18.0 | 14.0 | 0[e] |
| 4 in.$\phi$[d] | 6.3 | -- | 24.0 | 18.0 | 14.0 | 3 |
| 5 in.$\phi$[d] | 12.3 | -- | 24.0 | 18.0 | 14.0 | 3 |
| 6 in.$\phi$[d] | 21.2 | -- | 24.0 | 18.0 | 14.0 | 1 |
| 7 in.$\phi$[d] | 33.7 | -- | 24.0 | 18.0 | 14.0 | 0 |

[a]Data shown assumes posts have no weakened sections.

[b]As per criteria in Section IV-A-3.

[c]Subtract ½ inch for dressed dimensions. For example, a 4 in. x 4 in. has a dressed size of 3½ in. x 3½ in.

[d]Dimensions assumed at groundline.

[e]Values are for dressed sizes.

METRIC CONVERSIONS: 1 inch = 0.0254 m
1 ft = 0.305 m

## TABLE IV-D-1. IMPACT SAFETY EVALUATION OF TYPICAL SINGLE SUPPORTS FOR SMALL SIGNS

| POST TYPE | SIZE | SATISFY FOLLOWING CRITERIA: MOMENTUM CHANGE[a]? | TRAJECTORY OF SIGN AND SUPPORT[b]? | SECTION MODULUS[c]? |
|---|---|---|---|---|
| Steel U-Post Driven In Soil | 2 lb/ft | No data | Yes (1817-10) | Yes |
| | 3 lb/ft | No data | Yes (1817-14) | Yes |
| | 4 lb/ft | Yes[f] (1817-21 and 14) | Yes (1817-21) | Yes |
| | 6 lb/ft[d] | No (1817-39) | Yes (1817-24) | No |
| | 8 lb/ft[e] | No (1817-25) | No (1817-29) | No |
| Aluminum U-Post[h] Driven in Soil | 2X | No test | No test | Yes |
| | 3X | No test | No test | Yes |
| | 4X | Yes[f] (8) | No data | Yes |
| | 6 | No test | No test | Yes |
| | 8 | Yes[f] (12) | No data | No |
| Wood Post[i] | 4 in x 4 in | No test | No test | Yes |
| | 4 in x 6 in | No test | No test | Yes |
| | 6 in x 6 in | No test | No test | No |
| Standard Steel Pipe Driven in Soil | 2 inϕ | Yes[j] (1, 3, etc.) | Yes[j] (1, 3, etc.) | Yes |
| | 2½ inϕ | Yes[k] (4, 5, etc.) | Yes[k] (4, 5 etc.) | Yes |
| | 3 inϕ | No test | No test | Yes |
| | 3½ inϕ | No test | No test | No |
| | 4 inϕ | No test | No test | No |
| Standard Steel Pipe in Concrete Footing | 2 inϕ | No test | No test | Yes |
| | 2½ inϕ | Yes[l] (13) | Yes[l] (13) | Yes |
| | 3 inϕ | No test | No test | Yes |
| | 3½ inϕ | No test | No test | No |
| | 4 inϕ | No test | No test | No |
| Standard Steel Pipe on Breakaway Slip Base | 2 inϕ | No test | No test | Not Applicable |
| | 2½ inϕ | No test | No test | Not Applicable |
| | 3 inϕ | Yes (S-8, S-18) | Yes (S-8, S-18) | Not Applicable |
| | 3½ inϕ | No test | No test | Not Applicable |
| | 4 inϕ | No data | Yes (30) | Not Applicable |
| Standard Steel Tubing (Perforated By 7/16 in Holes On Four Sides 1 in. O.C.) | 1½ in x 1½ in[m] | No test | No test | Yes |
| | 2 in x 2 in[m] | No test | No test | Yes |
| | 2½ in x 2½ in[n] | Yes[f] (2) | Yes[f] (2) | Yes |
| Standard Steel I-Beam on Breakaway Slip Base | (NO SINGLE POST TEST) | | | |
| Standard Steel Pipe on Threaded Coupling[p] | 2 inϕ | Yes[q] (S-1) | No[q] (S-1) | Not Applicable |
| | 2½ inϕ | Yes (S-10, S-13, etc.) | Yes (S-10, S-13, etc.) | Not Applicable |
| | 3 inϕ | No test | No test | Not Applicable |

[a]As given in Sections IV-A-1 or IV-A-2. Number in parenthesis refers to test number in appropriate table of Appendix B used in evaluation.
[b]As given in Section IV-A-2. Number in parenthesis refers to test number in appropriate table of Appendix B used in evaluation.
[c]As given in Section IV-A-3.
[d]Two 3 lb/ft post bolted together back-to-back.
[e]Two 4 lb/ft post bolted together back-to-back.
[f]Based on low speed tests only. Response at high speeds unknown.

METRIC CONVERSIONS: 1 inch = 0.0254 m; 1 mph = 1.61 km/hr; 1 lb/ft = 1.49 kg/m; 1 ft = 0.305 m

[h]See footnote "f", Table IV-C-1.
[i]There were no reported tests of single wood post installations.
[j]For standard vehicle at speeds greater than 44 mph.
[k]For standard vehicle at speeds greater than 37 mph.
[l]For standard vehicle at 49 mph.
[m]Thickness is 0.105 in.
[n]Thickness is 0.135 in.
[p]See Figure III-B-4 for design.
[q]For standard vehicle at 44 mph.

## TABLE IV-D-2. IMPACT SAFETY EVALUATION OF TYPICAL DOUBLE SUPPORTS FOR SMALL SIGNS - ONE OF TWO POSTS HIT

| POST TYPE | SIZE | SATISFY FOLLOWING CRITERIA: MOMENTUM CHANGE[a]? | TRAJECTORY OF SIGN AND SUPPORT[b]? | SECTION MODULUS[c]? |
|---|---|---|---|---|
| Steel U-Post Driven In Soil | 2 lb/ft | No test | No test | Yes |
| | 3 lb/ft | No data | Yes (1811-5) | Yes |
| | 4 lb/ft | No test | No test | Yes |
| | 6 lb/ft[d] | Yes (1817-34) | Yes (1817-38) | No |
| | 8 lb/ft[e] | No (1817-40) | Yes (1817-40) | No |
| Aluminum U-Post[f] Driven In Soil | 2X | NO TESTS FOR 2 SUPPORTS | | Yes |
| | 3X | | | Yes |
| | 4X | | | Yes |
| | 6 | | | Yes |
| | 8 | | | No |
| Wood Post | 4 in x 4 in | No data | Yes (V I) | Yes[g] |
| | 4 in x 6 in | No data | Yes (UNAV) | Yes[g] |
| | 6 in x 6 in | No data | No (IV), Yes (III) | No[g] |
| | 6 in x 8 in | No data | No (X)[j], Yes (IX)[j] | No[g] |
| Standard Steel Pipe Driven In Soil | 2 inϕ | NO TESTS FOR 2 SUPPORTS | | Yes |
| | 2½ inϕ | | | Yes |
| | 3 inϕ | | | Yes |
| | 3½ inϕ | | | No |
| | 4 inϕ | | | No |
| Standard Steel Pipe in Concrete Footing | 2 inϕ | NO TESTS FOR 2 SUPPORTS | | Yes |
| | 2½ inϕ | | | Yes |
| | 3 inϕ | | | Yes |
| | 3½ inϕ | | | No |
| | 4 inϕ | | | No |
| Standard Steel Pipe on Break-away Slip Base | 2 inϕ | No test | No test | NOT APPLICABLE |
| | 2½ inϕ | No test | No test | |
| | 3 inϕ | No data | No data | |
| | 3½ inϕ | No test | No test | |
| | 4 inϕ | No test | No test | |
| Standard Steel Tubing (Perforated By 7/16 in Holes On Four Sides 1 in. O.C.) | 1½ in x 1½ in[h] | NO TESTS FOR 2 SUPPORTS | | Yes |
| | 2 in x 2 in[h] | | | Yes |
| | 2½ in x 2½ in[i] | | | Yes |
| | | | | Yes |
| Standard Steel I-Beam on Break-away Slip Base | 8WF20<br>315.7<br>5WF16 | Tests were run, but did not report data on momentum change or trajectory of sign and support. | | NOT APPLICABLE |
| Standard Steel Pipe on Threaded Coupling | | NO TESTS FOR 2 SUPPORTS | | NOT APPLICABLE |

[a]As given in Sections IV-A-1 or IV-A-2. Number in parenthesis refers to test number in appropriate table of Appendix B used in evaluation.

[b]As given in Section IV-A-2. Number in parenthesis refers to test number in appropriate table of Appendix B used in evaluation.

[c]As given in Section IV-A-3, assuming posts not within 8-foot path.

[d]Two 3 lb/ft sections back-to-back.

[e]Two 4 lb/ft sections back-to-back.

METRIC CONVERSIONS: 1 inch = 0.0254 m; 1 lb/ft = 1.49 kg/m; 1 mph = 1.61 km/hr; 1 ft = 0.305 m

[f]Size designations and moduli furnished by Magnode Products Inc. Posts are designed to provide bending strength about axis parallel to sign face equivalent to corresponding steel U-posts. Designating numbers represent weight per foot of corresponding steel U-posts. Limiting moduli based on 6061 T6 aluminum with ultimate strength of 42 ksi.

[g]With dressed sizes.

[h]Thickness is 0.105 in.

[i]Thickness is 0.135 in.

[j]Extruded aluminum channel sign. Posts had either 2½ in. diameter holes or 2 inch notches.

## TABLE IV-D-3. IMPACT SAFETY EVALUATION OF TYPICAL DOUBLE SUPPORTS FOR SMALL SIGNS - TWO OF TWO POSTS HIT

| | | SATISFY FOLLOWING CRITERIA: | | |
|---|---|---|---|---|
| POST TYPE | SIZE | MOMENTUM CHANGE[a]? | TRAJECTORY OF SIGN AND SUPPORT[b]? | SECTION MODULUS[c]? |
| Steel U-Post Driven In Soil | 2 lb/ft | No test | No test | Yes |
| | 3 lb/ft | No test | No test | Yes |
| | 4 lb/ft | No (3) | No data | No |
| | 6 lb/ft[d] | No (1817-6) | Yes (1817-6) | No |
| | 8 lb/ft[e] | No test | No test | No |
| Aluminum U-Post[f] Driven In Soil | 2X | No test | No test | Yes |
| | 3X | No test | No test | Yes |
| | 4X | Yes (9)[k] | No data | Yes |
| | 6 | No test | No test | No |
| | 8 | No test | No test | No |
| Wood Post | 4 in x 4 in | No data | Yes (V)[g] | Yes[h] |
| | 4 in x 6 in | No test | No test | No[h] |
| | 6 in x 6 in | No test | No test | No[h] |
| | 6 in x 8 in | No test | No test | No[h] |
| Standard Steel Pipe Driven in Soil | 2 inϕ | NO TESTS FOR 2 SUPPORTS | | Yes |
| | 2½ inϕ | | | No |
| | 3 inϕ | | | No |
| | 3½ inϕ | | | No |
| | 4 inϕ | | | No |
| Standard Steel Pipe in Concrete Footing | 2 inϕ | NO TESTS FOR 2 SUPPORTS | | Yes |
| | 2½ inϕ | | | No |
| | 3 inϕ | | | No |
| | 3½ inϕ | | | No |
| | 4 inϕ | | | No |
| Standard Steel Pipe on Break-away Slip Base | 2 inϕ | NO TESTS FOR 2 SUPPORTS | | NOT APPLICABLE |
| | 2½ inϕ | | | |
| | 3 inϕ | | | |
| | 3½ inϕ | | | |
| | 4 inϕ | | | |
| Standard Steel Tubing (Perforated By 7/16 in Holes On Four Sides 1 in. O.C.) | 1½ in x 1½ in[i] | No test | No test | Yes |
| | 2 in x 2 in[i] | No test | No test | Yes |
| | 2½ in x 2½ in | Yes (3)[j,k] | Yes (3)[j,k] | Yes[j] |
| Standard Steel I-Beam on Break-away Slip Base | 3I5.7<br>5WF16 | Tests were run, but did not report data on momentum change or trajectory of sign and support. | | NOT APPLICABLE |
| Standard Steel Pipe on Threaded Coupling | | NO TESTS FOR 2 SUPPORTS | | NOT APPLICABLE |

[a]As given in Sections IV-A-1 or IV-A-2. Number in parenthesis refers to test number in appropriate table of Appendix B used in evaluation.

[b]As given in Section IV-A-2. Number in parenthesis refers to test number in appropriate table of Appendix B used in evaluation.

[c]As given in Section IV-A-3, assuming posts within 8-foot path.

[d]Two 3 lb/ft sections back-to-back.

[e]Two 4 lb/ft sections back-to-back.

[f]Size designations and moduli furnished by Magnode Products, Inc. Posts are designed to provide bending strength about axis parallel to sign face equivalent to corresponding steel U-posts. Designating numbers represent weight per foot of corresponding steel U-posts. Limiting moduli based on 6061-T6 aluminum with ultimate strength of 42 ksi.

[g]Posts had either 1" diameter holes, ½" notches, or were plain.

[h]With dressed sizes.

[i]Thickness is 0.105 in.

[j]Thickness is 0.135 in.

[k]Based on low speed tests only. Response to higher speeds unknown.

[l]Extruded aluminum channel sign. Posts had either 2½ in. diameter holes or 2" notches.

METRIC CONVERSION: 1 inch = 0.0254 m; 1 lb/ft = 1.49 kg/m; 1 mph = 1.61 km/hr; 1 ft = 0.305 m on the highways, compact automobiles are now recommended in most instances for evaluating impact severity of roadside appurtenances. As a result the impact performance of many sign supports is unknown in terms of present guidelines.

Evaluation of the trajectory hazard of the sign and its support(s) is particularly difficult to evaluate, even if there are crash tests. Trajectory of the sign and its support(s) is a function of many variables, namely, size and weight of the blank, mounting height of the blank and mounting methods, vehicle geometry and weight, impact speed and angle, soil conditions in some designs, and others. About all that can be gained from a limited number of tests is a gross indication of the potential of a given sign support system to penetrate the passenger compartment of a vehicle.

It can be seen in Tables IV-D-1 through IV-D-2 that all of the currently used supports do not satisfy the safety criteria. Some satisfy only one part of the criteria while others do not satisfy any of the criteria. In some cases, there are conflicting results, i.e., the criteria is satisfied in one test and not satisfied in another.

It is noted that full-scale crash testing of many of the presently used supports is planned under this contract. If approved, all these tests will be for single support systems and all would adhere to present guidelines. A limited number of tests are also planned for promising new support systems.

## V. CONCLUSIONS

The following conclusions are based on results from the state-of-the-practice survey:

(1) There are a vast number of small sign installations within the state, city, county and toll road agencies. Within the state highway agencies alone there are in excess of six million single post installations.

(2) A significant expenditure is incurred each year for maintenance of small sign installations on the state, city and county levels.

(3) The most widely used designs for small sign supports are, in order of use, steel U-posts, wood posts, standard steel pipe, and square steel tubing.

(4) Breakaway bases are used on a small percentage of the total small sign installations. Most breakaway sign supports are used on freeways.

(5) With regard to methods of embedment, most U-posts are driven, most wood posts are placed in a drilled hole and backfilled, most pipe are placed in a concrete footing, and most square steel tubes are driven.

(6) A large majority of sign blanks for small signs are aluminum.

(7) When asked to estimate the total installation cost (including materials and labor) of typical small sign installations,

the respondents' data indicate that there is no significant difference in cost of the four most widely used support posts (see Item 3 above). However, an analysis of unit material cost data and labor estimates provided by the respondents showed otherwise. See the following two items. The beam type post (I-beam, W-beam, etc.) with a breakaway base costs considerably more than the four most widely used posts.

(8) Wood posts have the smallest unit material cost, followed by the steel U-posts, steel pipe, and the square steel tubing.

(9) Steel U-posts and steel pipe require the least labor to install, followed by the square or rectangular tube and then the wood posts.

(10) There was no significant difference in the repair cost (including materials and labor) of a typical small sign installation due to an "average" vehicle impact for the four most widely used support posts.

(11) A large part of many agencies' small sign maintenance is a result of vandalism.

The following conclusions are based on an evaluation of current sign support systems in terms of current safety evaluation criteria:

(1) Many sign support systems now in use cannot be evaluated in terms of current criteria (see Section IV-A) since they have never been subjected to full-scale crash tests.

(2) Of those systems that have been subjected to full-scale crash tests, some satisfy all criteria, others satisfy parts of the criteria, and some do not satisfy any of the criteria.

## REFERENCES

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18. Hirsch, T. J., Buth, E., "Crash Test of Mile Post Marker", Research Report No. 146-8, Texas Transportation Institute, Texas A&M University, January 1972.

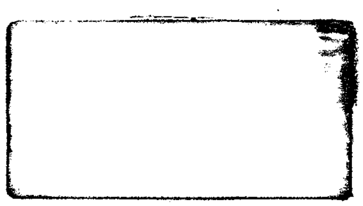
19. General Coupling Corporation, 2707 Durand Avenue, Racine, Wisconsin 53403.

20. Transpo-Safety Incorporated, 11 Lincoln Avenue, New Rochelle, New York 10801.

21. Foresight Industries, Incorporated, P. O. Box 4067, Cheyenne, Wyoming 82001.

22. Walker, Grant W., "Crash Test Evaluation of Single and Multiple Post Unistrut Sign Support Impacted by Light Car at Low Speed", Dynamic Research and Manufacturing Incorporated, Sacramento, California, July 1976.

23. FHWA Memorandum, from Acting Chief, Structures and Applied Mechanics Division, Office of Research to Mr. Lester A. Herr, Chief, Bridge Division, Office of Engineering, subject "Crash Test Evaluation of Single and Multiple Post Unistrut Sign Support Impacted by Light Car at Low Speed", October 27, 1976.



# APPENDIX A

## SURVEY FORM FOR GOVERNMENT AGENCIES

This Appendix contains the cover letter and questionnaire that was sent to various governmental agencies. A similar questionnaire was sent to various sign support suppliers and sign contractors.

TEXAS A&M UNIVERSITY
TEXAS TRANSPORTATION INSTITUTE
COLLEGE STATION TEXAS 77843

STRUCTURAL RESEARCH DIVISION

January 15, 1976

The Texas Transportation Institute is conducting a study entitled "Cost Effectiveness of Small Highway Sign Supports," under Federal Highway Administration contract, No. DOT-FH-8821. The objective of the study is to identify those support systems for small signs (panel area less than 50 sq. ft.) that are economical to install and maintain and that are not significant hazards to motorists.

A questionnaire is being mailed to each state, to local governmental agencies, sign manufacturers, and sign contractors. Enclosed is a copy which we are respectively requesting you to complete and return.

Two types of information are needed: design data and maintenance data. *If you are unable to provide all of the requested data, please provide what you can.* The information requested may require input from several sources within your agency. In some cases, field personnel may be the appropriate source.

An interim report, summarizing the questionnaire results, will be distributed to each respondent. We sincerely believe that the results of this survey will be beneficial to you and to others responsible for design, installation, and maintenance of such structures.

The questionnaire has been reviewed and approved by the Office of Management and Budget in accordance with the Federal Reports Act. The approval number assigned by O.M.B. appears in the upper right-hand corner of each page. *Please be assured that any data you provide will remain strictly confidential in accordance with the applicable federal regulations.*

Should you have questions, please write or call me collect at 713/845-4414. Your assistance and response by February 29, 1976 will be greatly appreciated.

Sincerely,

H. E. Ross, Jr.

Hayes E. Ross, Jr.
Associate Research Engineer
& Principal Investigator of Study

O.M.B. No. 04-S75061
Approval Expires November 1976

SURVEY OF CURRENT PRACTICE IN
SUPPORTS FOR SMALL SIGNS

Conducted by

Texas Transportation Institute
Texas A&M University
College Station, Texas 77843

Attn: Hayes E. Ross, Jr.
Phone: 713/845-4414

Project RF 3254 (G)

Contract No. DOT-FH-8821
Federal Highway Administration
Washington, D. C.

O.M.B. No. 04-S75061
Approval Expires November 1976

GENERAL COMMENTS AND INSTRUCTIONS

1. The questionnaire is composed of a section on General Questions and ten tables. The information requested is aimed primarily at sign supports and involves design, installation, and maintenance data. Please keep in mind that the data are needed for "small" roadside mounted signs. An arbitrary definition of "small" is that the total panel area be approximately 50 square feet or less. As such, the majority of signs of interest will be warning and regulatory signs, and to a lesser extent, some guide signs.
2. Please put the name and address of each respondent to the questionnaire on the appropriate line of Table 1, the Identification Form.
3. The General Questions and Table 2 can be filled out in any order desired. However, Table 3 must be filled out before completing the remainder of the questionnaire.
4. If the space provided for the data is inadequate, please feel free to write on the back of each page or provide data on a separate page. In addition, Table 10 provides space for comments, suggested improvements in sign support systems, etc.
5. To the extent possible, your response should be based on recorded or documented information. However, if recorded data are unavailable, your best estimate will be welcomed.
6. If you are unable to provide all of the data, <u>please provide what you can</u>.
7. Please return the completed questionnaire to:

   Hayes E. Ross, Jr.
   Texas Transportation Institute
   Texas A&M University
   College Station, Texas 77843

   A self addressed envelope is provided to return the questionnaire.

TABLE 1.

IDENTIFICATION FORM

O.M.B. No. 04-S75061
Approval Expires November 1976

Agency Name: ____________________

| Column 1 | Column 2 | Column 3 | Column 4 | Column 5 |
|---|---|---|---|---|
| Parts of Questionnaire Filled Out | Name of Respondent | Address | Title | Phone Number |
| General Questions | | | | |
| Table 2 | | | | |
| Table 3 | | | | |
| Table 4 | | | | |
| Table 5 | | | | |
| Table 6 | | | | |
| Table 7 | | | | |
| Table 8 | | | | |
| Table 9 | | | | |
| Table 10 | | | | |

*Information on this sheet will remain confidential. It is included to permit future contact with respondents for additional data or possibly a clarification of data.*



O.M.B. No. 04-S75061
Approval Expires November 1976

GENERAL QUESTIONS

1. Listed below are several factors that generally are considered important in selection of a sign support system. Please rank them in the numerical order of importance that in your opinion applies in your agency.

   Availability of materials (for replacements) ____

   Amount of maintenance required (man-power and equipment) ____

   Initial (including site preparation) and maintenance costs ____

   Collision hazard to motorist ____

   Others (please specify) ____________________

2. (a) For the same panel size, does your agency generally use different support systems for various functional classes of roadways (freeways, secondary, etc.)? ☐ Yes ☐ No

   (b) If so, please explain briefly the differences ____________________

3. What percentage of roadway signs on NEW roads or major reconstruction projects in your jurisdiction are installed by:

   (a) Contractors? ______%

   (b) Your agency? ______%

4. What percentage of roadway signs on EXISTING roads in your jurisdiction are:

   (a) Maintained by contractors? _______%

   (b) Maintained by your agency? _______%

5. (a) When signs are installed by a contractor on a NEW road, what percentage of the time are they included as a part of a larger contract? _______%

   (b) If included as a part of a larger contract, can sign costs be determined readily? ☐ Yes ☐ No

6. (a) Is an inventory maintained of the signs currently in place alongside your roadways? ☐ Yes ☐ No

   (b) Are the signs categorized according to type or size? ☐ Yes ☐ No

   (c) Are they categorized according to some other criteria (e.g., by sign function, material, etc.)? ☐ Yes ☐ No
   Please specify ______________________________

7. (a) Are records of sign installation and maintenance activities (including cost information) maintained

   (1) by your agency? ☐ Yes ☐ No

   (2) by other agencies within your jurisdiction? ☐ Yes ☐ No

   (b) Do these records contain information that could be used (either directly or indirectly) to identify such items as number of supports repaired, maintenance man-power requirements, etc.? ☐ Yes ☐ No

   (c) Would these records be available to the researchers, after proper clearance, if they wished to evaluate the data? ☐ Yes ☐ No





8. What is the approximate total number of signs (all sizes) currently in place along your roadways? _______

9. (a) Please estimate the percentage of total in-place signs that have panel area of approximately 50 square ft. area or less _______%

   (b) Of the percentage given in (a), estimate the percentage of sign systems that are

   (1) single post system _______%

   (2) multiple post system _______%

   (Total = 100 %)

10. What was your agency's <u>total</u> maintenance expenditure during the immediate past fiscal year? $_______

   (a) What percentage of the <u>total</u> maintenance expenditure was devoted to sign maintenance (all sign sizes)? _______%

   (b) What percentage of the total maintenance expenditure was devoted to maintenance of signs having panel area of approximately 50 square ft. or less? _______%

11. Are roadside accident data records (other than normal police accident reports) maintained

   (a) by your agency? ☐ Yes ☐ No

   (b) by other agencies within your jurisdiction (e.g., field districts or divisions)? ☐ Yes ☐ No

   (c) Do these records contain information that could be used (either directly or indirectly) to identify such items as type of sign impacted, damage to sign and vehicle, injuries to occupant, etc.? ☐ Yes ☐ No

   (d) Would these records be available to the researchers, after proper clearance, if they wished to evaluate the data? ☐ Yes ☐ No

12. Are cost-evaluation analyses generally conducted on your signing installations ☐ Yes ☐ No

(a) Are typical analyses available? ☐ Yes ☐ No

(b) Please specify source: ______________________________

13. What interest rate is used by your agency in computing present value of future costs? ______%





COMMENTS ON TABLE 2

1. The information on this table is needed to determine the types of <u>supports</u> used by your agency for small signs and the extent of their use. Note that Part 1 is for <u>single</u> post signs and Part 2 is for <u>multiple</u> post signs.

2. *It would be very helpful if you could send a copy of standard design details of your sign support systems. Also, if not included on the design details, please provide criteria used by your agency to determine the number and size of supports as related to panel area, sign type, etc.*

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TABLE 2 (Part 1 of 2)
SMALL SIGN SUPPORT USAGE - SUPPORT POST (SINGLE POST SIGN)

| Column 1 | Column 2 | Column 3 | Column 4 | Column 5 | Column 6 |
|---|---|---|---|---|---|
| Cross-Sectional Shape | Material | Sizes Used | Estimated % Usage | Design | Remarks |
| *See Note 1* | *See Note 2* | *See Note 3* | *See Note 4* | *See Note 5* | |
| | | | | | |
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Notes:

1. Use general shape categories [e.g., tubular, square, wide flange (or other rolled shapes), U-Section (or other formed shapes), etc.].
2. Use specific material (e.g., A36 steel, Douglas Fir timber, aluminum, plastic, etc.).
3. Specify sizes used for each cross-sectional shape category in Column 1 (e.g., square 4" x 4"; tubular 3"ϕ; I-beam 3I5.7, etc.). Please specify individual support sizes used for each category in Column 1 where possible, otherwise specify size ranges.
4. Estimate percentage of the total "small" sign population (area ≤ 50 sq. ft.) that use this support.
5. Specify type of base design: Fixed (F), Yielding or base-bending (Y), Breakaway (B).

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TABLE 2 (Part 2 of 2)
SMALL SIGN SUPPORT USAGE - SUPPORT POST (MULTIPLE POST SIGN)

| Column 1 | Column 2 | Column 3 | Column 4 | Column 5 | Column 6 |
|---|---|---|---|---|---|
| Cross-Sectional Shape | Material | Sizes Used | Estimated % Usage | Design | Remarks |
| *See Note 1* | *See Note 2* | *See Note 3* | *See Note 4* | *See Note 5* | |
| | | | | | |
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Notes:

1. Use general shape categories [e.g., tubular, square, wide flange (or other rolled shapes), U-section (or other formed shapes), etc.].
2. Use specific material (e.g., A36 steel, Douglas Fir timber, aluminum, plastic, etc.).
3. Specify sizes used for each cross-sectional shape category in Column 1 (e.g., square 4" x 4"; tubular 3"ϕ; I-beam 3I5.7, etc.). Please specify individual support sizes used for each category in Column 1 where possible, otherwise specify size ranges.
4. Estimate percentage of the total "small" sign population (area ≤ 50 sq. ft.) that use this support.
5. Specify type of base design: Fixed (F), Yielding or base-bending (Y), Breakaway (B).

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COMMENTS ON TABLE 3

1. The information requested on this table concerns support details for three of your most widely used single post signs and three of your most widely used multiple post signs. Please keep in mind that the emphasis in this questionnaire is on the support system itself.

2. Note that the supports you describe are given an A-B-C designation for the three single post systems and an A-B-C designation for the three multiple post systems. *Please list the supports for single post signs according to their extent of use, i.e., "A" is most widely used, "B" is second most widely used, and "C" is third most widely used. Please list the supports for the multiple post signs in the same manner.* All remaining tables refer back to these designations. For example, information is requested in Table 4 on the stub post, footing, and sign panel used with the supports described in Table 3.





TABLE 3

DETAILED DESIGN DATA FOR SIGN SYSTEMS MOST WIDELY USED - SIGN SUPPORT POST

| | Column 1 | Column 2 | Column 3 | Column 4 | | Column 5 | Column 6 | Column 7 |
|---|---|---|---|---|---|---|---|---|
| | Sign System Designation | Cross-Sectional Shape and Typical Size | Material | Hinge Below Sign | | Type of Base Design | Breakaway Mechanism | Remarks |
| | *See Note 1* | *See Note 2* | *See Note 3* | Yes | No | *See Note 4* | *See Note 5* | |
| SINGLE POST SIGNS | A | | | | | | | |
| | B | | | | | | | |
| | C | | | | | | | |
| MULTIPLE POST SIGNS | A | | | | | | | |
| | B | | | | | | | |
| | C | | | | | | | |

Notes:

1. The designations, A-B-C, are reference codes. Refer to Table 3 comments for definition of codes. These codes are used in Tables 3 through 9.
2. For example, 3I5.7, Std. Pipe -3"ϕ, Square -4" x 4", U-Post -4lb/ft, etc.
3. For example, A36 Steel, Douglas Fir Timber, etc.
4. Specify type of base design: Fixed (F), Yielding or base-bending (Y), Breakaway (B).
5. State if slip base, weakened (notched) section, frangible section or casting, threaded pipe coupling, etc. State "none" for fixed or yielding system.

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TABLE 4

DETAILED DESIGN DATA FOR SIGN SYSTEMS MOST WIDELY USED - STUB-POST, FOOTING, SIGN PANEL

| | | Stub-Post | | | | | Footing *See Note 5* | | | Sign Panel(s) |
|---|---|---|---|---|---|---|---|---|---|---|
| | Column 1 | Column 2 | Column 3 | Column 4 | | Column 5 | Column 6 | Column 7 | | Column 8 |
| | Sign System Designation | Cross-Sectional Shape and Typical Size | Material | Typical Length (in.) | | Method of Embedment | Diameter (in.) | Typical Length (in.) | | Sign Blank Material |
| | | | | Total | Above Ground | | | Total | Above Ground | |
| | *See Note 1* | *See Note 2* | *See Note 3* | | | *See Note 4* | | | | *See Note 6* |
| SINGLE POST SIGNS | A | | | | | | | | | |
| | B | | | | | | | | | |
| | C | | | | | | | | | |
| MULTIPLE POST SIGNS | A | | | | | | | | | |
| | B | | | | | | | | | |
| | C | | | | | | | | | |

Notes:

1. See Table 3 comments for definition of sign system designation codes.
2. For example, 3I5.7, Std. Pipe -3"ϕ, square -4" x 4", U-Post -4lb/ft, etc.
3. For example, A36 Steel, Douglas Fir Timber, etc.
4. For example, driven, mounted in concrete footing, backfilled, etc.
5. Applies only if concrete footing used for foundation.
6. For example, aluminum, steel, plywood, plastic, etc.



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TABLE 5

GENERAL DATA

| | Column 1 | Column 2 | | Column 3 | | Column 4 | Column 5 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Sign System Designation | Approximate Number Installed | | Design Life (Years) | | Full-Scale Crash Test | Does Support Satisfy AASHTO Dynamic Criteria? | | |
| | | Rural | Urban | Support | Panel(s) | | *See Note 3* | | |
| | *See Note 1* | | | | | *See Note 2* | Yes | No | Unknown |
| SINGLE POST SIGNS | A | | | | | | | | |
| | B | | | | | | | | |
| | C | | | | | | | | |
| MULTIPLE POST SIGNS | A | | | | | | | | |
| | B | | | | | | | | |
| | C | | | | | | | | |

Notes:

1. See Table 3 comments for sign system designation code definition.
2. Please list any reports or papers that document any full-scale tests relating to the sign system. Copies of such reports will be appreciated.
3. Reference: AASHTO publication, "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals," Section 7, paragraph 1.7.2, pg. 55, 1975.

COMMENTS ON TABLE 6

The data in this table concern the costs and manpower to install the given sign systems on either a new roadway or a major reconstruction project. If possible, exclude overhead and transportation charges from your cost figures.





TABLE 6
INSTALLATION DATA

| | | Complete Sign System Data | | | Footing and/or Stub Post | | Support Post | | Sign Panel | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Column 1 | Column 2 | Column 3 | Column 4 | Column 5 | Column 6 | Column 7 | Column 8 | Column 9 | Column 10 |
| | Sign System Designation | Total Cost of Sign Installation ($/Sign) | % of Total Cost for Labor (% of Col. 2) | Total Labor (No. of man-hours Labor) for Sign Installation (man-hrs/sign) | % of Total Sign Cost For Footing (% of Col. 2) | % of Total Labor Man-Hours for Footing Installation (% of Col. 4) | % of Total Sign Cost For Support Post (% of Col. 2) | % of Total Labor Man-Hours for Support Post Installation (% of Col. 4) | % of Total Sign Cost For Sign Panel (% of Col. 2) | % of Total Labor Man-Hours for Sign Panel Installation (% of Col. 4) |
| | *See Note 1* | *See Note 2* | | *See Note 3* | | | *See Note 4* | | *See Note 5* | |
| SINGLE POST SIGNS | A | | | | | | | | | |
| | B | | | | | | | | | |
| | C | | | | | | | | | |
| MULTIPLE POST SIGNS | A | | | | | | | | | |
| | B | | | | | | | | | |
| | C | | | | | | | | | |

Notes:

1. See Table 3 comments for definition of sign system designation codes.
2. Specify total cost of sign system including material, site preparation, labor for installation. (Please base cost estimates on a per-sign basis assuming 100 sign installations.)
3. Include labor for site preparation and installation.
4. Include cost of windbeams if used.
5. Include cost of sign blank and sign face (reflectorization, legend, etc.)

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COMMENTS ON TABLE 7

The information requested in this table is needed primarily to determine the costs of spare parts. Maintenance personnel may therefore be the most appropriate group to provide these data.



TABLE 7

MATERIAL UNIT COST DATA

*See Note 1*

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| | Column 1 | Column 2 | Column 3 | Column 4 | Column 5 | Column 6 |
|---|---|---|---|---|---|---|
| | Sign System Designation | Footing | Stub Post | Support Post | Sign Panel | Miscellaneous Hardware |
| | *See Note 2* | *See Note 3* | | *See Note 4* | *See Note 5* | *See Note 6* |
| SINGLE POST SIGNS | A | | | | | |
| | B | | | | | |
| | C | | | | | |
| MULTIPLE POST SIGNS | A | | | | | |
| | B | | | | | |
| | C | | | | | |

Notes:

1. Please provide unit cost data in units you think appropriate; for example, dollars/pound, dollars/ft., etc. For computational purposes, assume purchase of materials for 100 sign systems.
2. See Table 3 comments for sign system designation code definition.
3. Disregard if concrete footing not used.
4. Include cost of windbeams if used. (Show cost breakdown.)
5. Include cost of sign blank and face (reflectorization, legend, etc.)
6. Bolts, nuts, etc.

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COMMENTS ON TABLE 8

1. A large portion of maintenance activities related to signs results from vehicle hits. The selection of a support system should include a consideration of the collision repair costs and manpower requirements. It is therefore important that accurate and detailed information on collision repair be provided.

2. Note that the requested information is to be based on an "average" or typical collision. Ideally, such information could be obtained by averaging records from a number of accidents with the given sign, system (A, B, or C). However, if such records are not readily available, it is hoped that "best estimates" will be provided. Such estimates can probably be best obtained from maintenance personnel.

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TABLE 8

COLLISION REPAIR INFORMATION

*See Note 1*

| | Column 1 | Column 2 | Column 3 | Column 4 | Column 5 | Column 6 | Column 7 | Column 8 | Column 9 | Column 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Estimated % of Sign Repair Jobs that Involve: | | | | | |
| | Sign System Designation | Estimated Total Cost to Repair Sign System As Result of "Average" Collision ($/sign) | % of Total Cost For Labor (% of Col. 2) | Estimated Total Labor To Repair Sign System As Result of "Average" Collision (man-hrs/sign) | Replacement of Complete Sign System (Including Footing) | Replacement of ONLY Support Post | Replacement of ONLY Sign Panel | Replacement of BOTH Support Post and Panel | No Replacement (Repair damaged Parts Only) | Special Equipment |
| | *See Note 2* | | | | | | | | | *See Note 3* |
| SINGLE POST SIGNS | A | | | | | | | | | |
| | B | | | | | | | | | |
| | C | | | | | | | | | |
| MULTIPLE POST SIGNS | A | | | | | | | | | |
| | B | | | | | | | | | |
| | C | | | | | | | | | |

Notes:

1. The data in this table apply ONLY to maintenance resulting from vehicle/sign collision (not "normal" maintenance such as cleaning, vandalism repair, etc.)
2. See Table 3 comments for sign system designation code definition.
3. Identify any special equipment needed to replace and/or repair components (use reverse side of page if necessary).

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TABLE 9

NORMAL MAINTENANCE DATA

*See Note 1*

| | Column 1 | Column 2 | Column 3 | Column 4 | Column 5 | Column 6 | Column 7 | Column 8 |
|---|---|---|---|---|---|---|---|---|
| | Sign System Designation | Estimated Annual Maintenance Cost Per Sign ($/Sign/Yr) | Estimated Annual Labor Involved in Maintenance (man hrs/sign/yr) | Estimated % of Maintenance Due to Labor (% of Col. 2) | Estimated % of Maintenance Cost Due to: Vandalism | Wind-Caused Failures | Other Causes | Maintenance Attributes or Problems |
| | *See Note 2* | *See Note 3* | | | | | | *See Note 4* |
| SINGLE POST SIGNS | A | | | | | | | |
| | B | | | | | | | |
| | C | | | | | | | |
| MULTIPLE POST SIGNS | A | | | | | | | |
| | B | | | | | | | |
| | C | | | | | | | |

Notes:

1. The data in this table apply to all maintenance EXCEPT vehicle/sign collision repairs (collision data were supplied in Table 8).
2. See Table 3 comments for sign system designation code definition.
3. Include all costs attributable to normal maintenance activity including labor, materials, and equipment.
4. Please state any unique maintenance features or problems associated with the particular sign system (use reverse side of page if necessary).

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TABLE 10

COMMENTS

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| |
|---|
| Please state any comments you may have regarding the questionnaire, the information requested and any ideas that you may have to improve the impact performance (crashworthiness), cost considerations, or other factors of consideration in signing practices for "small" signs. |
| |

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# APPENDIX B

## CRASH TEST RESULTS

This Appendix contains a summary of data on crash tests of sign supports, in particular, those that are used for small sign installations.

TABLE B-1

FULL SCALE U-POST TEST DATA

STEEL

| | | POST DATA | | | | | SIGN DATA[g] | AUTOMOBILE DATA | | | TEST RESULTS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TEST NO. | DATE AND AGENCY | MATERIAL | SIZE (lb/ft) | NO. IN SIGN | NO.[k] HIT | METHOD OF[h] EMBEDMENT | SIZE OF SIGN BLANK | WEIGHT (lb) | SPEED (mph) | CHANGE IN MOMENTUM[a] (lb-sec) | ACCELERATION[b] (g) | SIGN HIT WINDSHIELD? | SIGN HIT TOP OF AUTO? |
| 1 | 1974 New Jersey DOT (9) | Steel | 4.0 | 3 | 1 | driven | UNAV | 2000 | 20-25 | 485 | 5.9 | UNAV[c] | UNAV |
| 5 | | | 4.0 | 3 | 1 | driven | UNAV | 2000 | 20-25 | 1450 | 7 | UNAV[d] | UNAV |
| 14 | | | 4.0 | 1 | 1 | driven | UNAV | 2000 | 20-25 | 640 | 5.0 | UNAV | UNAV |
| 3 | | | 4.0 | 2 | 2 | driven | UNAV | 2000 | 20-25 | 1320 | 7.4 | UNAV | UNAV |
| 4 | | | 4.0 | 2 | 2 | driven | UNAV | 2000 | 20-25 | 1500 | 9 | UNAV | UNAV |
| 15 | | | 4.0 | 2 | 2 | driven | UNAV | 3000 | 20-25 | 1160 | 8.6 | UNAV | UNAV |
| 17 | | | 4.0 | 2 | 2 | driven | UNAV | 2000 | 20-25 | 1120 | 6.6 | UNAV | UNAV |
| 6 | | | 4.0 | 3 | 3 | driven | UNAV | 2000 | 20-25 | 970 | 6 | UNAV[e] | UNAV |
| 19 | | | 4.0 | 3 | 3 | driven | UNAV | 2000 | 20-25 | 1940 | 9 | UNAV[f] | UNAV |
| 16 | | | 4.0 | 3 | 3 | driven | UNAV | 2000 | 20-25 | 1700 | 7.8 | UNAV | UNAV |
| 18 | | | 4.0 | 3 | 3 | driven | UNAV | 2000 | 20-25 | 1500 | 8.7 | UNAV | UNAV |
| 2 | | | 4.0 | 4 | 4 | driven | UNAV | 2000 | 20-25 | 2030 | 23 | UNAV[i] | UNAV |
| 7 | | | 4.0 | 4 | 4 | driven | UNAV | 2000 | 20-25 | 2100 | 10 | UNAV | UNAV |
| 1817-3 | Ohio Dept. of Transp. & Univ. of Cincinnati July, 1974 May, 1970 (10, 11) | Steel | 6 | 1 | 1 | driven 60" | 48 in² | 3900 | 35 | 1190 | 2.5 | no | yes |
| 1817-4 | | | 8 | 1 | 1 | driven 66" | 48" x 60" | 3500 | 37 | 1810 | 1.86 | no | no |
| 1817-6 | | | 6 | 2 | 2 | driven 60" | 36" x 96" | 3500 | 34 | 1840 | 2.78 | no | yes |
| 1817-21 | | | 4 | 1 | 1 | driven 48" | 36" diamond | 3350 | 30 | 760 | 0.53 | no | no |
| 1817-22 | | | 4 | 1 | 1 | driven 48" | 36" diamond | 3350 | 28 | 580 | 1.18 | no | no |
| 1817-24 | | | 6 | 1 | 1 | driven 60" | 48" rect. | 3550 | 35 | 840 | 0.59 | no | no |
| 1817-25 | | | 8 | 1 | 1 | driven 66" | 48" x 60" | 3600 | 31.5 | 1890 | 3.11 | no | no |
| 1817-28 | | | 6 | 2 | 1 L | driven 60" | 4' x 12' | 4100 | 27 | 2260 | 2.71 | no | no |
| 1817-29 | | | 8 | 1 | 1 | driven 66" | 48" x 60" | 3550 | 24 | 1700 | 2.60 | yes | no |
| 1817-30 | | | 8 | 2 | 1 L | driven 66" | 4' x 14' | 3550 | 34 | 2080 | 3.10 | no | no |
| 1817-31 | | | 8 | 1 | 1 | concrete | 48" x 60" | 3900 | 36 | 1810 | 1.16 | no | yes |
| 1817-34 | | | 6 | 2 | 1 L | driven 60" | 2' x 13' | 3550 | 27 | 1040 | 5.65[j] | no | yes |
| 1817-35 | | | 6 | 1 | 1 | concrete | 48 in² | 4100 | 19.5 | 1550 | 2.1 | no | no |
| 1817-36 | | | 8 | 2 | 1 L | driven 66" | 4' x 13' | 3900 | 31 | 1800 | 0.97 | yes | no |
| 1817-37 | | | 8 | 2 | 1 L | driven 66" | 4' x 13' | 3900 | 28.5 | 2180 | 1.73 | no | no |
| 1817-38 | | | 6 | 2 | 1 L | driven 60" | 4' x 13' | 4100 | 31.5 | 2150 | 1.64 | no | no |
| 1817-39 | | | 6 | 1 | 1 | driven 60" | 48 in² | 4100 | 19 | 1490 | 1.06 | no | no |
| 1817-40 | | | 8 | 2 | 1 | concrete | 4' x 13' | 3550 | 33 | 1860 | 2.28 | no | no |

[a] Data during impact only.
[b] Peak accelerations on tests 1-19.
[c] Post broke from sign panel during impact.
[d] Post did not break away from sign.
[e] Left post not attached to sign panel and was yielded at bumper height prior to impact.
[g] Mounting height was not available.
[f] Power to accelerometer lost during impact.
[h] Numbers to the side indicate depth of embedment in inches.
[i] Vehicle overturned during impact.
[j] Value is for peak acceleration.

METRIC CONVERSIONS:

1 lb/ft = 1.49 kg/m
1 inch = 0.0254 m
1 foot = 0.305 m
1 lb/sec = 4.45 Ns
1 g = 9.82 $m/s^2$

TABLE B-1 (cont.)

FULL SCALE U-POST TEST DATA (cont.)

STEEL

| TEST NO. | DATE AND AGENCY | POST DATA: MATERIAL | POST DATA: SIZE (lb/ft) | POST DATA: NO. IN SIGN | POST DATA: NO. HIT[b] | POST DATA: METHOD OF[a] EMBEDMENT | SIGN DATA: SIZE OF SIGN BLANK | SIGN DATA: MTG. HT. | AUTOMOBILE DATA: WEIGHT (lb) | AUTOMOBILE DATA: SPEED[b] (mph) | TEST RESULTS: CHANGE IN MOMENTUM (lb-sec) | TEST RESULTS: ACCELERATION (g) | TEST RESULTS: SIGN HIT WINDSHIELD? | TEST RESULTS: SIGN HIT TOP OF AUTO? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1817-SP4 | Univ. of Cincinnati May, 1970 (11) | Steel | 2 | 1 | 1 | driven (S) | 2' x 2' | UNAV | 2050 | 4.0 | UNAV | UNAV | UNAV | UNAV |
| 1817-SP5 | | | 2 | 1 | 1 | driven (S) | 2' x 2' | UNAV | 2050 | 5.0 | UNAV | UNAV | UNAV | UNAV |
| 1817-SP11 | | | 2 | 1 | 1 | driven (S) | 2' x 2' | UNAV | 2050 | 11.0 | UNAV | .770 | UNAV | UNAV |
| 1817-SP14 | | | 2 | 1 | 1 | driven (S) | 2' x 2' | UNAV | 2050 | 14.0 | UNAV | 1.7 | UNAV | UNAV |
| 1817-SP18 | | | 2 | 1 | 1 | driven (S) | 2' x 2' | UNAV | 2050 | 18.4 | UNAV | .90 | UNAV | UNAV |
| 1817-ACL11 | | | 2 | 1 | 1 | driven (C) | 2' x 2' | UNAV | 2050 | 11.0 | UNAV | 1.08 | UNAV | UNAV |
| 1817-ACL18 | | | 2 | 1 | 1 | driven (C) | 2' x 2' | UNAV | 2050 | 18.4 | UNAV | 1 67 | UNAV | UNAV |
| 1817-BCL11 | | | 2 | 1 | 1 | driven (C) | 2' x 2' | UNAV | 2050 | 11.0 | UNAV | .834 | UNAV | UNAV |
| 1817-BCL18 | | | 2 | 1 | 1 | driven (C) | 2' x 2' | UNAV | 2050 | 18 4 | UNAV | 813 | UNAV | UNAV |
| S-6 | TTI Aug., 1973 (12) | Steel | 2.2 | 1 | 1 | driven | 1' x 2'8" | 3' 4" | 3970 | 61.3 | 160 | 1.1 | no | no |
| S-9 | | | 2.2 | 1 | 1 | driven | 1' x 2'8" | 3' 4" | 3970 | 45.2 | 160 | 0.5 | no | no |
| S-15 | | | 2.2 | 1 | 1 | driven | 1' x 2'8" | 3' 4" | 4170 | 28.1 | 91 | 0.2 | no | no |
| 16 | Wayne State Univ. 1972 (13) | Steel | 8.0[c] | 1 | 1 | driven | 4' x 5' | 7' 0" | 4500 | 54.8 | 728 | 3.8 | no | no |
| 17 | | | 8.0 | 1 | 1 | concrete | 4' x 5' | 7' 0" | 4500 | 57.7 | UNAV | UNAV | no | no |
| 18 | | | 8.0 | 1 | 1 | driven[d] | 4' x 5' | 7' 0" | 2514 | 30.3 | 960 | 4.4 | no | yes |
| 1817-1 | Univ. of Cincinnati May, 1970 (11) | Steel | 3 | 1 | 1 | driven 36" | 2½' x 2½' | 5' | 1953 Buick | 48 | UNAV | 0.2 | no | no |
| 1817-2 | | | 4 | 1 | 1 | driven 48" | 36" diamond | 7' | " | 45 | UNAV | 1.33 | no | yes |
| 1817-5 | | | 3 | 2 | 1 L | driven 48" | 18" x 96" | 7' | " | 46 | UNAV | 1.0 | no | no |
| 1817-7 | | | 2 | 1 | 1 | driven 36" | 2' x 2' | 7' | 1960 Chev. | 10 | UNAV | minimal | no | no |
| 1817-8 | | | 2 | 1 | 1 | driven 36" | 2' x 2' | 7' | " | 20 | UNAV | minimal | no | no |
| 1817-9 | | | 2 | 1 | 1 | driven 36" | 2' x 2' | 7' | " | 30 | UNAV | minimal | no | no |
| 1817-10 | | | 2 | 1 | 1 | driven 36" | 2' x 2' | 7' | " | 40 | UNAV | minimal | no | no |
| 1817-11 | | | 3 | 1 | 1 | driven 48" | 2½' x 2½' | 7' | 1960 Dodge | 10 | UNAV | 0.3 | no | no |
| 1817-12 | | | 3 | 1 | 1 | driven 48" | 2½' x 2½' | 7' | " | 20 | UNAV | 0.75 | no | no |
| 1817-13 | | | 3 | 1 | 1 | driven 48" | 2½' x 2½' | 7' | " | 30 | UNAV | 1.15 | no | yes |
| 1817-14 | | | 3 | 1 | 1 | driven 48" | 2½' x 2½' | 7' | 1960 Chev. | 40 | UNAV | 3.42 | no | no |
| 1817-15 | | | 3 | 1 | 1 | driven 48" | 30" diamond | 7' | 1960 Chev. | 10 | UNAV | 0.11 | no | no |
| 1817-16 | | | 3 | 1 | 1 | driven 48" | 30" diamond | 7' | " | 20 | UNAV | 0.5 | no | no |
| 1817-17 | | | 3 | 1 | 1 | driven 48" | 30" diamond | 7' | " | 30 | UNAV | 0.74 | no | no |
| 1817-18 | | | 3 | 1 | 1 | driven 48" | 30" diamond | 7' | " | 40 | UNAV | 1.0 | no | no |
| 1817-19 | | | 4 | 1 | 1 | driven 48" | 36" diamond | 7' | " | 10 | UNAV | 0.08 | no | no |
| 1817-20 | | | 4 | 1 | 1 | driven 48" | 36" diamond | 7' | 1956 Dodge | 20 | UNAV | 0.6 | no | no |
| 1817-23 | | | 8 | 1 | 1 | concrete | 48" x 60" | 7' | 3600 | 48 | 1320 | 2.25 | no | no |
| 1817-26 | | | 6 | 2 | 1 L | driven 60" | 4' x 12' | 7' | 1959 Ford | 30 | UNAV | 1.64 | no | no |
| 1817-27 | | | 8 | 2 | 1 L | driven 66" | 4' x 14' | 7' | " | 30 | UNAV | 1.73 | no | no |
| 1817-32 | | | 6 | 1 | 1 | concrete | 48" diamond | 7' | 1954 Buick | 50 | UNAV | 1.18 | no | yes |
| 1817-33 | | | 4 | 1 | 1 | driven 48" | 36" diamond | 7' | 1959 Ford | 30 | UNAV | 0.74 | no | no |

[a]Numbers to the side indicate embedment in inches.

[b]When only one of two posts was hit, it is indicated which one, either left (L), or right (R) was hit.

[c]An 8lb/ft post consists of two 4lb/ft back-to-back.

Note: In tests 1817-SP4 through 1817-BCL18, type of soil used is indicated by either sand (S), or clay (C).
Note: In tests 1817-SP4 through 1817-BCL18, impact velocities are given since speed was not given.
Note: In tests 1817-15 through 1817-18, and in test 1817-33, the angle of incidence was 45°.
Note: The State of Ohio currently uses a steel sign support which is a modified channel cross section. The posts are available in sections weighing two, three, and four pounds per foot. The three and four pound sections are sometimes bolted back to back to form larger sections of six and eight pounds respectively.

METRIC CONVERSIONS:
1 lb/ft = 1.49 kg/m
1 inch = 0.0254 m
1 ft = 0.305 m
1 lb-sec = 4.45 Ns
1 g = 9.82 $m/s^2$

TABLE B-1 (cont.)

FULL SCALE U-POST TEST DATA (cont.)

STEEL

| TEST NO. | DATE AND AGENCY | POST DATA: MATERIAL | SIZE[d] (lb/ft) | NO. IN SIGN | NO. HIT | METHOD OF EMBEDMENT[a] | SIGN DATA[b]: SIZE OF SIGN BLANK | AUTOMOBILE DATA: WEIGHT (lb) | SPEED (mph) | TEST RESULTS: CHANGE IN MOMENTUM (lb-sec) | ACCELERATION (g) | SIGN HIT WINDSHIELD? | SIGN HIT TOP OF AUTO? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2466-1 | Ohio Dept. of Transp. & Univ. of Cincinnati July, 1974 (10) | Steel | 8 lb. | 1 | 1 | driven 66" | 4' x 5' | 4100 | 29.3 | 1180 | UNAV | no | no |
| 2466-2 | ↓ | ↓ | 8 lb. | 1 | 1 | driven 66" | 4' x 5' | 4100 | 43.7 | 1610 | UNAV | no | no |
| 2466-3 | ↓ | ↓ | 8 lb. | 1 | 1 | driven 66" | 4' x 5' | 4400 | 43.9 | 1700 | UNAV | no | yes |
| 2466-4 | ↓ | ↓ | 8 lb. | 1 | 1 | concrete[c] | 4' x 5' | 4400 | 30.4 | 2050 | UNAV | no | no |
| 2466-5 | ↓ | ↓ | 8 lb. | 1 | 1 | concrete | 4' x 5' | 3880 | 45.8 | 1780 | UNAV | no | yes |
| 2466-6 | ↓ | ↓ | 8 lb. | 1 | 1 | concrete | 4' x 5' | 3750 | 49.5 | 1570 | UNAV | no | no |
| 2466-7 | ↓ | ↓ | 8 lb. | 1 | 1 | driven 66" | 4' x 5' | 3850 | 31.7 | 2000 | UNAV | no | no |
| 2466-8 | ↓ | ↓ | 8 lb. | 1 | 1 | driven 66" | 4' x 5' | 3850 | 45.6 | 2170 | UNAV | no | no |
| 2466-9 | ↓ | ↓ | 8 lb. | 1 | 1 | driven 66" | 4' x 5' | 3800 | 47.8 | 1770 | UNAV | no | no |

[a] Numbers to the side indicate depth of embedment in inches.
[b] The mounting height for all signs in these tests was 7 feet.
[c] The concrete embedments were 12 inches in diameter and 4 feet deep.
[d] All posts were 8 lb. "piggy-back".

METRIC CONVERSIONS:

1 lb/ft = 1.49 kg/m
1 inch = 0.0254 m
1 foot = 0.305 m
1 lb-sec = 4.45 Ns
1 g = 9.82 $m/s^2$

TABLE B-2

FULL SCALE U-POST TEST DATA

ALUMINUM

| | | POST DATA | | | | | SIGN DATA[m] | AUTOMOBILE DATA | | TEST RESULTS | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TEST NO. | DATE AND AGENCY | MATERIAL | SIZE[n] (lb/ft) | NO. IN SIGN | NO. HIT | METHOD OF EMBEDMENT | SIZE OF SIGN BLANK | WEIGHT (lb) | SPEED (mph) | CHANGE IN[a] MOMENTUM (lb-sec) | ACCELERATION[b] (g) | SIGN HIT WINDSHIELD? | SIGN HIT TOP OF AUTO? |
| 22 | 1974 New Jersey DOT (9) | Aluminum | 4.0 | 3 | 1 | driven | UNAV | 2000 | 35-45 | 310 | 3.4 | UNAV[c,h,i] | UNAV |
| 26 | | | 4.0 | 4 | 1 | driven | 4' x 8' | 2000 | 20-25 | 850 | 6.0 | UNAV[c] | UNAV |
| 8 | | | 4.0 | 1 | 1 | driven | UNAV | 2000 | 20-25 | 170 | 2.5 | UNAV[h] | UNAV |
| 12 | | | 8.0 | 1 | 1 | driven | UNAV | 2000 | 20-25 | 800 | 7.7 | UNAV[j] | UNAV |
| 9 | | | 4.0 | 2 | 2 | driven | UNAV | 2000 | 20-25 | 910 | 4.6 | UNAV[h] | UNAV |
| 11 | | | 4.0 | 2 | 2 | driven | UNAV | 2000 | 20-25 | 1050 | 4.6 | UNAV | UNAV |
| 21 | | | 4.0 | 3 | 2 | driven | UNAV | 4500 | 40-45 | 800 | 3.9 | UNAV[k] | UNAV |
| 10 | | | 4.0 | 3 | 3 | driven | UNAV | 2000 | 20-25 | 1140 | 7.3 | UNAV[h] | UNAV |
| 24 | | | 4.0 | 3 | 3 | driven | UNAV | 2000 | 20-25 | 950 | 7.8 | UNAV | UNAV |
| 23 | | | 4.0 | 3 | 3 | driven | UNAV | 2000 | 35-45 | 880 | 6.7 | UNAV[i] | UNAV |
| 25 | | | 4.0 | 3 | 3 | driven | UNAV | 2000 | 35-45 | 700 | 5.9 | UNAV[i] | UNAV |
| 20 | | | 4.0 | 3 | 3 | driven | UNAV | 4500 | 40-45 | 1560 | 5.2 | UNAV[k] | UNAV |
| 13 | | | 4.0 | 4 | 4 | driven | UNAV | 2000 | 20-25 | 1440 | 6.9 | UNAV | UNAV |

[a] Data during impact only
[b] Peak acceleration.
[c] Post broke from sign panel during impact.
[h] No film to corroborate accelerometer data.
[i] 2000-lbm (907-kg) vehicle impacting at 20 deg and 35 to 45 mph (57 to 72 km/hr)
[j] Post equivalent to 8 lbf/ft (117 N/m) steel piggyback.
[k] 4500-lbm (1941-kg) vehicle impacting at 10 deg and 40 to 45 mph (64 to 72 km/hr)
[m] Mounting height of signs was unavailable.
[n] All of the aluminum posts tested were equivalent in strength to the given size of steel.

METRIC CONVERSIONS:
1 lb/ft = 1.49 kg/m
1 inch = 0.0254 m
1 foot = 0.305 m
1 lb-sec = 4.45 Ns
1 g = 9.82 $m/s^2$

TABLE B-3

FULL SCALE WOOD POST TEST DATA

| | | POST DATA | | | | | SIGN DATA | | AUTOMOBILE DATA | | TEST DATA | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TEST NO. | DATE AND AGENCY | MATERIAL | SIZE | NO. IN SIGN | NO.[a] HIT | METHOD OF EMBEDMENT | SIZE OF SIGN BLANK | MTG. HT. | WEIGHT (lb) | SPEED (mph) | CHANGE IN MOMENTUM (lb-sec) | ACCELERATION (g) | SIGN HIT WINDSHIELD? | SIGN HIT TOP OF AUTO? |
| I | Bureau of Materials, | Wood | 6" x 6" | 2 | 1 L | 4'-5' auger, | 5' x 10' | 5' | 1964 Ford | 40 | UNAV | UNAV | yes | no |
| II | Testing, and Research | ↓ | 6" x 6" | 2 | 1 R | embedded in one-foot | " | 5' | " | 40 | UNAV | UNAV | no | yes |
| III | (Penn. Dept. of Highways) | ↓ | 6" x 6" | 2 | 1 R | layer of stone, then | " | 5' | " | 40 | UNAV | UNAV | no | yes |
| IV | 1965 (14) | ↓ | 6" x 6" | 2 | 1 L | backfilled with sand | " | 5' | UNAV | 40 | UNAV | UNAV | yes | no |
| V | ↓ | ↓ | 4" x 4" | 2 | 2 | | 5' x 5' | 5' | 1964 Ford | 40 | UNAV | UNAV | no | yes |
| VI | ↓ | ↓ | 4" x 4" | 2 | 1 L | | 5' x 5' | 5' | UNAV | 40 | UNAV | UNAV | no | no |
| VII | ↓ | ↓ | 4" x 4" | 2 | 1 L | | " | 5' | UNAV | 40 | UNAV | UNAV | no | no |
| VIII | ↓ | ↓ | 4" x 4" | 2 | 1 R | | " | 5' | 1964 Ford | 40 | UNAV | UNAV | UNAV | UNAV |
| IX | ↓ | ↓ | 6" x 8"[b] | 2 | 1 L | | 4' x 10'[b] | 7' | " | 40 | UNAV | UNAV | no | yes |
| X | ↓ | ↓ | 6" x 8"[b] | 2 | 1 L | | 4' x 10'[b] | 7' | " | 40 | UNAV | UNAV | yes | no |
| 151 | State of Calif. Transp. Agency 1967 | Wood | 6" x 8" | 2 | 1 L | Compacted sand backfill | 5' x 14' | 7' | 4540 | 38 | 414 | 0.62 | no | no |
| 152 | (17) | ↓ | d = 11" | 2 | 1 [illegible] | | 10' x 20' | 7' | 4540 | 40 | 829 | 1.24 | Back windshield | yes |
| 153 | ↓ | ↓ | d = 11" | 2 | 1 L | | 10' x 20' | 7' | 2000 | 39 | 1096 | 2.48 | no | no |
| UNAV | Michigan Dept. of State Hwys. | Wood | 4" x 6" nominal[c] | 2 | 1 | UNAV | Cluster | 7' | Sedan | 53 | UNAV | UNAV | no | no |
| 43 | TTI, 1965 (15) | Wood | 4" x 6"[d] | 2 | 2 | UNAV | 5' x 6' | UNAV | UNAV | 39.8 | UNAV | UNAV | no | no |

[a] When only one of two posts was hit, it is indicated which one, either left (L), or right (R), was hit.
[b] Extruded aluminum channel sign.
[c] Two holes drilled through N.A. for plane of weakness. Holes were 1 3/4 inches in diameter, one 6" above ground, other 1' 6" above ground.
[d] A slot 2" wide was cut through the post just below bumper level.

Note: Tests I through IV had either 1½" diameter holes or 3/4" notches for weakness from 6" to 2' from groundline. Tests V through VIII had either 1" diameter holes, ½" notches, or no holes in posts. Tests IX and X had either 2½" diameter holes or 2" notches in posts.

Note: Approach angle in tests 151, 152, and 153 was 90°.
Note: In test 153, cross sectional area of timber post was reduced to approx. 51.8 $in^2$ by drilling three 4" diameter holes in it at 4", 10", and 16" above groundline.

METRIC CONVERSIONS:

- 1 lb/ft = 1.49 kg/m
- 1 inch = 0.0254 m
- 1 foot = 0.305 m
- 1 lb-sec = 4.45 Ns
- 1 g = 9.82 $m/s^2$

TABLE B-4

FULL SCALE PIPE POST TEST DATA

| TEST NO. | DATE AND AGENCY | POST DATA: MATERIAL | SIZE (diam) | NO. IN SIGN | NO. HIT | METHOD OF EMBEDMENT | SIGN DATA: SIZE OF SIGN BLANK | MTG. HT. | AUTOMOBILE DATA: WEIGHT (lb) | SPEED (mph) | TEST RESULTS: CHANGE IN MOMENTUM (lb-sec) | ACCELERATION (g) | SIGN HIT WINDSHIELD? | SIGN HIT TOP OF AUTO? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S-1[a] | TTI Aug., 1973 (12) | Steel | 2" | 1 | 1 | concrete | 1' x 4' | 4' 0" | 3400 | 43.9 | 248 | UNAV | yes | no |
| S-2[b] | | | 1.25" | 1 | 1 | concrete | 1' x 4' | 4' 0" | 3970 | 38.2 | 246 | 0.5 | no | no |
| S-3[c] | | | 1.25" | 1 | 1 | driven | 1' x 4' | 4' 0" | 3970 | 31.0 | 259 | 0.5 | no | no |
| S-4[c] | | | 1.25" | 1 | 1 | driven | 1' x 4' | 4' 0" | 3970 | 59.4 | 99 | 0.4 | no | no |
| S-5[c] | | | 1.25" | 1 | 1 | driven | 1' x 4' | 4' 0" | 3970 | 44.9 | 148 | 0.6 | no | no |
| S-7[d] | | | 2" | 1 | 1 | concrete | 1' x 4' | 4' 0" | 3970 | 47.5 | 456 | 2.5 | no | no |
| S-8[f] | | | 3" | 1 | 1 | concrete | 1'6" x 7'10" | 7' 0" | 3970 | 46.0 | 136 | 1.7 | no | no |
| S-10[e] | | | 2.5" | 1 | 1 | concrete | 2.5' x 2.5' | 9' 6" | 3970 | 45.5 | 296 | 2.4 | no | yes |
| S-11[f] | | | 5" | 1 | 1 | concrete | 8'6" x 2' | 7' 0" | 3970 | 44.5 | 259 | 2.1 | no | yes |
| S-12[b] | | | 1.25" | 1 | 1 | concrete | 1' x 4' | 4' 0" | 4170 | 56.9 | 155 | 0.5 | yes | no |
| S-13[e] | | | 2.5" | 1 | 1 | concrete | 4' x 1'4" | 7' 0" | 4170 | 44.2 | 285 | 1.5 | no | yes |
| S-14[e] | | | 2.5" | 1 | 1 | concrete | 4' x 1'4" | 7' 0" | 4170 | 30.2 | 453 | 1.4 | no | no |
| S-16[e] | | | 2.5" | 1 | 1 | concrete | 4' x 1'4" | 7' 0" | 4170 | 58.4 | 246 | 1.3 | no | yes |
| S-17[f] | | | 5" | 1 | 1 | concrete | 8'6" x 2' | 7' 0" | 4170 | 45.5 | 324 | 5.2 | no | yes |
| S-18[f] | | | 3" | 1 | 1 | concrete | 1'6" x 7'10" | 7' 0" | 4170 | 31.3 | 168 | 2.0 | no | no |
| 1[c] | Wayne State Univ. 1972 (13) | Steel | 2" | 1 | 1 | driven | 1.5' x 2' | 7.5' | 3720 | 44.3 | 476 | 1.8 | no | no |
| 2[c] | | | 2" | 1 | 1 | driven | 1.5' x 2' | 8' | 3720 | 45 | UNAV | UNAV | no | no |
| 3[c] | | | 2" | 1 | 1 | driven | 1.5' x 2' | 7' | 3720 | 57.6 | 999 | 2.6 | no | UNAV |
| 6[c] | | | 2" | 1 | 1 | driven | 1.5' x 2' | 8' | 3720 | 48.2 | 427 | 2.1 | no | no |
| 7[c] | | | 2" | 1 | 1 | driven | 1.5' x 2' | 7' | 3720 | 36.7 | 693 | 1.5 | no | no |
| 8[c] | | | 2" | 1 | 1 | driven | 1.5' x 2' | 8' | 2445 | 65.4 | 128 | 2.1 | no | no |
| 9[c] | | | 2" | 1 | 1 | driven | 1.5' x 2' | 8' | 3400 | 59.2 | 158 | 1.2 | no | no |
| 10[c] | | | 2" | 1 | 1 | driven | 1.5' x 2' | 8' | 3265 | 63.4 | 268 | 2.8 | no | no |
| 4[c] | | | 2.5" | 1 | 1 | driven | 2' x2.5' | 8' | 3720 | 37.5 | 554 | 1.8 | no | no |
| 5[c] | | | 2.5 " | 1 | 1 | driven | 2' x 2.5' | 7' | 3720 | 58.2 | 554 | 4.3 | no | no |
| 11[c] | | | 2.5" | 1 | 1 | driven | 2' x 2.5' | 8' | 3345 | 48.7 | 630 | 1.6 | no | no |
| 13[b] | | | 2.5" | 1 | 1 | concrete | 2' x 2.5' | 8' | 3265 | 48.9 | 843 | 4.7 | no | no |
| 15[c] | | | 2.5" | 1 | 1 | driven | 2' x 2.5' | 8' | 2826 | 71.3 | 983 | 6.6 | no | no |
| 26[g] | TTI-1965 (15) | Steel | 4" | 1 | 1 | concrete | Cluster | 6' 9" | 1955 Ford | 45 | UNAV | UNAV | no | yes |
| 27[g] | | | 3" | 1 | 1 | concrete | Cluster | 6' 9" | 1954 Ford | 45 | UNAV | UNAV | no | no |
| 30[h] | | | 4" | 1 | 1 | concrete | Cluster | 6' 9" | 1955 Chev. | 35 | UNAV | UNAV | no | no |
| 34[h] | | | 3" | 1 | 1 | concrete | Cluster | 6' 9" | 1955 Chev. | 35 | UNAV | UNAV | no | no |
| 36[h] | | | 3"dual | 2 | 1 | concrete | over 13' long | UNAV | 1954 Chev. | 30 | UNAV | UNAV | no | no |
| 37[h] | | | 2-7/8" thin wall | 1 | 1 | concrete | Cluster | 6' 9" | 1956 Ford | 50 | UNAV | UNAV | no | yes |
| 38[i] | | | 3" | 1 | 1 | concrete | Cluster | 6' 9" | 1956 Ford | 35 | UNAV | UNAV | no | no |
| UNAV[a] | TTI-1972 (18) | Steel | 2" | 1 | 1 | concrete | 1' x 4' | 4' 0" | 3400 | 43.9 | 248 | UNAV | yes | yes |

[a]Breakaway feature: 2 inch coupling.
[b]Breakaway feature: None - post in concrete.
[c]Breakaway feature: None - post driven in soil.
[d]Breakaway feature: 2 inch coupling with 1½" insert.
[e]Breakaway feature: 2.5 inch coupling.
[f]Breakaway feature: Multi-directional slip base.

[g]Horizontal breakaway slip base used, impact angle was 15°.
[h]20° inclined breakaway slip base used, impact angle was 15°.
[i]10° inclined breakaway slip base used, impact angle was 15°.

METRIC CONVERSIONS: 1 lb/ft = 1.49 kg/m; 1 inch = 0.0254 m; 1 ft = 0.305 m; 1 lb-sec = 4.45 Ns; 1 g = 9.82 $m/s^2$

TABLE B-5

FULL SCALE I-BEAM POST TEST DATA

| | | POST DATA | | | | | SIGN DATA | | AUTOMOBILE DATA | | TEST RESULTS | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TEST NO | DATE AND AGENCY | MATERIAL | SIZE | NO. IN SIGN | NO. HIT[a] | METHOD OF EMBEDMENT | SIZE OF SIGN BLANK | MTG. HT. | WEIGHT (lb) | SPEED (mph) | CHANGE IN MOMENTUM (lb-sec) | ACCELERATION (g) | SIGN HIT WINDSHIELD? | SIGN HIT TOP OF AUTO? |
| UNAV | TTI-1971 | Steel | 8WF20 | 2 | 1 | UNAV | 8' x 16' | 8' | 3620 | 42.5 | 200 | 2.5 | no | no |
| 12 | TTI-1965 (15) | A-7 Steel | 3I5.7 | 2 | 2 | UNAV | 5' x 6' | 7' | 1955 Dodge | 55 | UNAV | UNAV | UNAV | UNAV |
| 14 | | | " | 2 | 2 | UNAV | 5' x 6' | 7' | " | 25 | UNAV | UNAV | UNAV | UNAV |
| 15 | | | " | 2 | 2 | UNAV | 5' x 6' | 7' | 1954 Ford | 35 | UNAV | UNAV | UNAV | UNAV |
| 16 | | | " | 2 | 1-L | UNAV | 5' x 6' | 7' | " | 25 | UNAV | UNAV | UNAV | UNAV |
| 17 | | | " | 2 | 1-L | UNAV | 5' x 6' | 7' | " | 45 | UNAV | UNAV | UNAV | UNAV |
| 18 | | | " | 2 | 2 | UNAV | 5' x 6' | 7' | " | 45 | UNAV | UNAV | UNAV | UNAV |
| 19 | | | 5WF16# | 2 | 2 | UNAV | 5' x 6' | 7' | 1955 Dodge | 45 | UNAV | UNAV | UNAV | UNAV |
| 20 | | | " | 2 | 2 | UNAV | 5' x 6' | 7' | 1954 Ford | 50 | UNAV | UNAV | UNAV | UNAV |
| 21 | | | 3I5.7 | 2 | 2 | UNAV | 5' x 6' | 7' | " | 25 | UNAV | UNAV | UNAV | UNAV |
| 22 | | | " | 2 | 2 | UNAV | 5' x 6' | 7' | " | 50 | UNAV | UNAV | UNAV | UNAV |
| 23 | | A36 Steel | 5WF16# | 2 | 2 | UNAV | 5' x 6' | 7' | 1953 Ford | 45 | UNAV | UNAV | UNAV | UNAV |
| 24 | | A-7 Steel | 3I5.7 | 2 | 2 | UNAV | 5' x 6' | 7' | 1954 Ford | 45 | UNAV | UNAV | UNAV | UNAV |
| 25 | | A-7 Steel | 3I5.7 | 2 | 1-L | UNAV | 5' x 6' | 7' | 1954 Ford | 50 | UNAV | UNAV | UNAV | UNAV |
| 28 | | | 5WF16# | 2 | 1-L | UNAV | 5' x 6' | 7' | 1955 Olds | 22 | UNAV | UNAV | UNAV | UNAV |
| 29 | | | " | 2 | 2 | UNAV | 5' x 6' | 7' | 1955 Pont. | 45 | UNAV | UNAV | UNAV | UNAV |
| 31 | | | 3I5.7 | 2 | 2 | UNAV | 5' x 6' | 7' | 1954 Chev. | 30 | UNAV | UNAV | UNAV | UNAV |
| 32 | | | 5WF16# | 2 | 2 | UNAV | 5' x 6' | 7' | 3230 | 45 | UNAV | 80 (peak) | UNAV | UNAV |

[a]When only one of two posts was hit, it is indicated which one, either left (L), or right (R), was hit.

METRIC CONVERSIONS:
- 1 lb/ft = 1.49 kg/m
- 1 inch = 0.0254 m
- 1 foot = 0.305 m
- 1 lb-sec = 4.45 Ns
- 1 g = 9.82 m/s$^2$

TABLE B-6

FULL-SCALE TESTS ON SQUARE STEEL TUBING, TELESCOPING DESIGN

| | | POST DATA | | | | | SIGN DATA | | AUTOMOBILE DATA | | TEST RESULTS | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TEST NO. | DATE AND AGENCY | MATERIAL | SIZE | NO. IN SIGN | NO. HIT | METHOD OF EMBEDMENT | SIZE OF SIGN BLANK | MTG. HT. | WEIGHT (lb) | SPEED (mph) | CHANGE IN MOMENTUM (lb-sec) | ACCELERATION (g) | SIGN HIT WINDSHIELD? | SIGN HIT TOP OF AUTO? |
| 1 | 1974 Dynamics Research and Manufacturing Incorporated | Steel | 2½"x2½" 12 Gauge | 1 | 1 | Driven 36"[a] $L_I$=20"[b] | 30"x30" Diamond | 5' | 3000 | 52 | UNAV | UNAV | NO[c] | NO |
| 2 | (16) | ↓ | | 1 | 1 | Driven 36"[a] $L_I$=15"[b] | | | | 53 | UNAV | UNAV | NO[c] | NO |
| 3 | ↓ | ↓ | | 1 | 1 | Driven 36"[a] $L_I$=12"[b] | | | | 61 | UNAV | UNAV | NO[c] | YES |
| 1 | 1976 Dynamics Research and Manufacturing Incorporated | Steel | 2½"x2½" 10 Gauge | 3 | 2 | Driven 36"[a] $L_I$UNAV[b] | 96"x48" Plywood | 6' | 2620 | 24.3 | 1480 (1462)[d] | UNAV | UNAV | UNAV |
| 2 | (22) | ↓ | | 1 | 1 | Driven 36"[a] $L_I$UNAV[b] | 4'x4' Diamond | 8' | 2620 | 22.7 | 675 (362)[d] | <1.0 | NO | NO |
| 3 | ↓ | ↓ | | 2 | 2 | Driven 36"[a] $L_I$UNAV[b] | 48"x72" Plywood | 6' | 2260 | 21.3 | 1112 (809)[d] | UNAV | NO | NO |

[a] 3"x3" Anchor driven and post mounted in anchor. Anchor was driven through a 2" layer of asphalt.

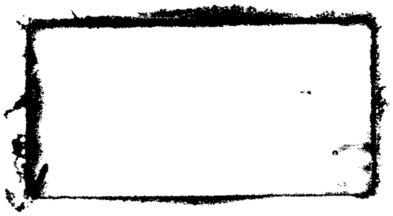
[b] $L_I$ is depth post inserted in anchor.

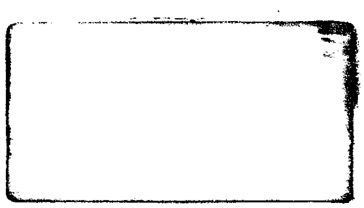
[c] Vehicle braked immediately after impact.

[d] According to FHWA calculations (23).

METRIC CONVERSIONS:

1 lb/ft = 1.49 kg/m
1 inch = 0.0254 m
1 foot = 0.305 m
1 lb-sec = 4.45 Ns
1 g = 0.82 m/s$^2$





# APPENDIX C

## DETAILED RESULTS OF SURVEY

Note: This appendix contains a complete description of the results of the survey of current practice in small sign supports. In some instances, data presented in Appendix C are also given in Chapter III. Although this results in some repetition, it was felt that the data should be presented *in toto* and as such, Appendix C is autonomous.

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DETAILED RESULTS OF SURVEY


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## C-1. INTRODUCTION

The past few years have seen the evolution of the "forgiving roadway" concept. The breakaway or yielding roadside sign support has contributed significantly to this evolution. Since that time, several other impact forgiving roadside structures have emerged, including lightpoles, crash cushions, overhead sign bridge supports, and guardrail terminals. However, application of these features is by no means consistent or uniform throughout the nation.

Efforts are now being made to inform the public of the need of a forgiving roadside and the need to eliminate roadside "booby traps". Highway departments are being subjected to increasing pressures from the legal community through court actions. It is apparent that these highway officials need to be cognizant of the state-of-the-art in the highway safety area. They also need guidelines that are as concise as possible and that can be implemented without undue effort.

Seeing such a need, the Federal Highway Administration entered into a contract (Contract No. DOT-FH-8821) with the Texas A&M Research Foundation to conduct a study entitled "Cost-Effectiveness of Small Highway Sign Supports". The actual research has been performed by the Texas Transportation Institute staff.

### Purpose of Study

The purpose of this study is to acquaint highway officials with the state-of-the art in highway safety relating specifically to small signs and to provide these officials with guidelines in selecting cost-effective small sign support systems. The ultimate objective of this research is to develop a comprehensive but concise procedural manual specifically designed and prepared for intensive and widespread use by those highway officials and their consultants, contractors, and materials suppliers that are responsible for the selection, construction, and maintenance of highway sign support systems. The scope of this research is limited to an evaluation of installation, repair, and normal maintenance costs, a determination of the crashworthiness of the currently used small sign support systems (with panels having an area up to 50 square feet (4.64 sm), and reporting the findings and recommendations regarding the most cost-effective sign support systems.

The research contract specified that the necessary design, cost and crashworthiness data be obtained primarily by means of a survey questionnaire mailed to state and local highway departments, sign contractors, sign supplier, etc. The contract also called for a detailed and comprehensive review and evaluation of the existing literature on the safety of small sign support systems as reported by highway organizations, highway researchers, and highway contractors.

The purpose of this report is to present the findings of the mail survey and the extensive literature review. The results presented in this report reveal the state-of-the-practice with respect to the design, cost and crashworthiness of existing small sign support systems.

## Sample Design

The data collection plan called for mailing out questionnaires to all of the 50 state highway agencies and to a selected number of appropriate federal agencies, state turnpike authorities, cities, counties, and sign suppliers and contractors. The selection of those other than state highway agencies is based on the following criteria:

(1) Must have the responsibility of supplying, installation, and/or maintenance of small sign systems on highways or streets.

(2) Must supply, install, and/or maintain enough small signs to provide reasonably accurate cost and crashworthiness data.

(3) Must be recommended by state or federal highway officials as being potentially good respondents because the names of the appropriate officials in the organization or company are known.

Separate questionnaires were designed for government agencies, sign support suppliers, and sign contractors to collect the appropriate data from each group. Before the questionnaires were finalized and approved, they were pretested by sending them to several state agencies, sign suppliers, and sign contractors. Also, copies were sent to several Federal Highway Administration officials (Technical Advisory Committee) for their review and approval.

The survey plan called for mailing out a maximum of 250 questionnaires, thus severely limiting the number of potential respondents, other than the 50 state highway agencies that could be surveyed. The selections were made from lists of 50 states, 59 turnpikes, 3,141 counties, 1,300 largest cities, and approximately 450 sign suppliers and contractors.

Table C-1 shows the actual number of questionnaires that were mailed and received along with the response percentages of each type of respondent. The overall response of 45 percent is considered very good for mail questionnaires.

Table C-1.

Rate of Response to the Sign Support Survey Questionnaire, by Type of Respondents Sampled

| Type | Number Mailed | Number Received | Response Percentage |
|---|---|---|---|
| Government Agencies | | | |
| State Highway Departments | 50 | 48 | 96 |
| Cities | 84 | 36 | 43 |
| Counties | 62 | 16 | 26 |
| Toll Roads | 11 | 4 | 36 |
| Federal Agencies | 12 | 6 | 50 |
| Territories | 2 | 1 | 50 |
| Subtotal | 221 | 111 | 50 |
| Sign Support Suppliers | 24 | 9 | 38 |
| Sign Support Erectors | 30 | 5 | 17 |
| Total Respondents Sampled | 275 | 125 | 45 |

## Characteristics of Respondents

The survey respondents are characterized on the basis of type and location. Table C-2 shows the number and percentage of respondents by type. Almost 89 percent are government agencies, with the state highway departments making up the largest group of this type. Sign support suppliers make up 7.2 percent and contractors account for the remaining 4.0 percent.

Table C-3 shows the number of various types of respondents located in each region of the country. Figure 1 shows the states included in each region. The Standard Highway Administrative Regions are used for a geographical breakdown, because states within the same region may be influenced to use similar sign support standards. Cross-tabulating by region should reveal the amount of differences in sign designs and costs that may exist among regions. Each region has from 4 to 8 respondent cities and/or counties represented in the survey. Three regions have toll road respondents, and 4 regions have federal agency respondents. Therefore, the different types of respondents are scattered reasonably well across the regions.

Table C-2.

Number and Percentage of Respondents
by Type of Respondent

| Type of Respondent | Respondents Number | | Respondents Percent* | |
|---|---|---|---|---|
| Government Agencies | 111 | | 88.8 | |
| State Highway Departments | | 48 | | 38.4 |
| Cities (includes Washington, D.C.) | | 37 | | 29.6 |
| Counties | | 16 | | 12.8 |
| Toll Roads | | 4 | | 3.2 |
| Federal Agencies | | 6 | | 4.8 |
| Sign Support Suppliers | 9 | | 7.2 | |
| Sign Support Contractors | 5 | | 4.0 | |
| Total Respondents | 125 | | 100.0 | |

*Percent of all respondents.

Table C-3.

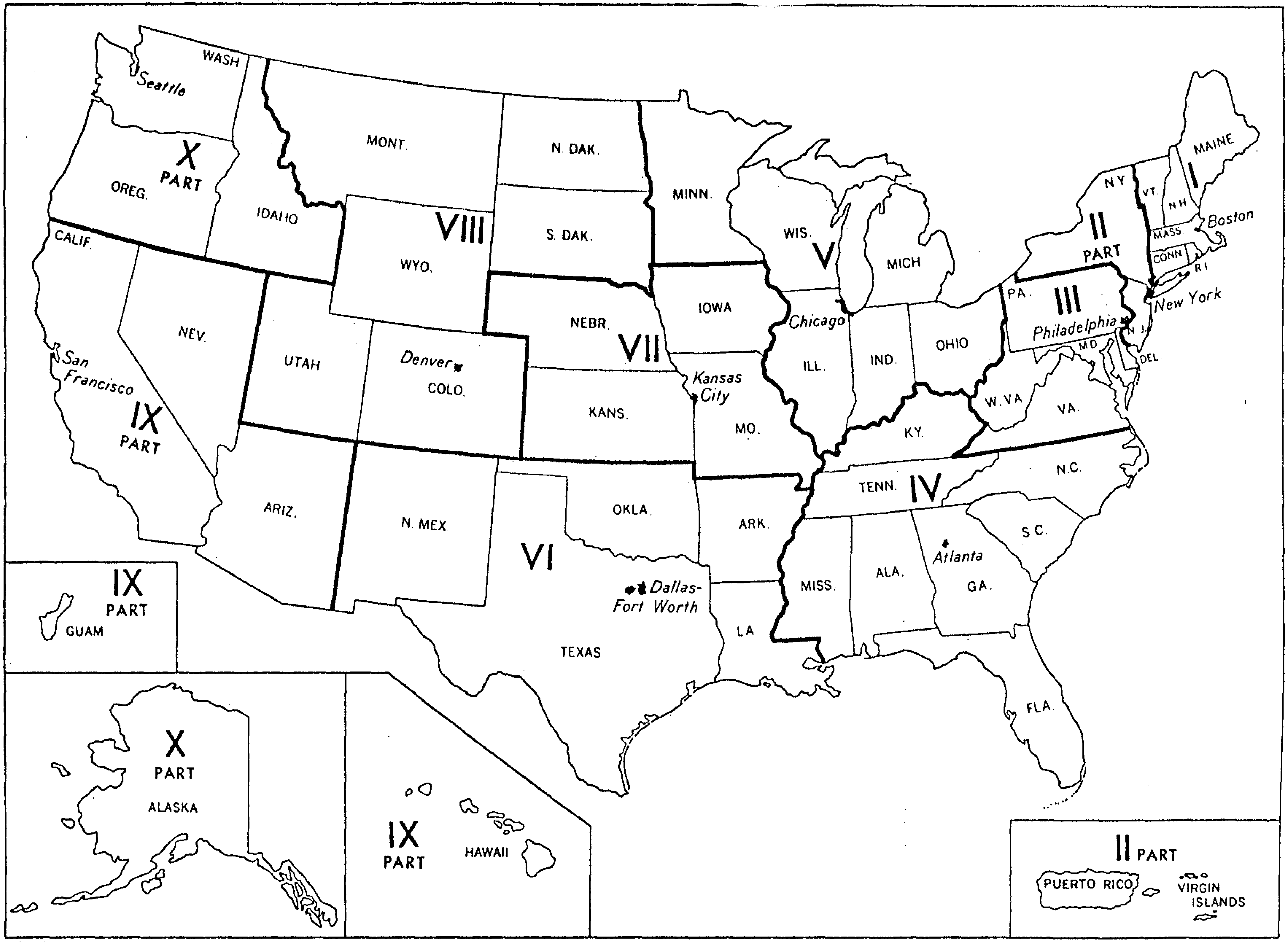
Regional Location of Respondents
by Type of Respondent

| Region* | Type of Respondents | | | | |
|---|---|---|---|---|---|
| | Government Agencies | | Sign Suppliers | Sign Contractor | Total |
| | State | Other** | | | |
| | -- | -- | Number | -- | -- |
| Region 1&2 | 8 | 10 | 1 | 1 | 20 |
| Regions 3 | 5 | 6 | 2 | 1 | 14 |
| Region 4 | 8 | 4 | 0 | 0 | 12 |
| Region 5 | 6 | 9 | 4 | 2 | 21 |
| Region 6 | 4 | 10 | 0 | 1 | 15 |
| Region 7 | 4 | 8 | 1 | 0 | 13 |
| Region 8 | 6 | 6 | 1 | 0 | 13 |
| Region 9 | 3 | 5 | 0 | 0 | 8 |
| Region 10 | 4 | 5 | 0 | 0 | 9 |
| Total Respondents | 48 | 63 | 9 | 5 | 125 |

*See Figure 1 for location of designated regions.

**Includes federal agencies and territories, state turnpikes, cities, and counties.

Figure C-1. **STANDARD FEDERAL ADMINISTRATIVE REGIONS**




U.S. DEPARTMENT OF COMMERCE SOCIAL AND ECONOMIC STATISTICS ADMINISTRATION BUREAU OF THE CENSUS

## C-2. GENERAL DATA ON HIGHWAY SIGNS

The questionnaires were designed to obtain general data on highway signs, such as the type of records maintained on signs, extent of and type of sign contracting practiced, level of sign maintenance expenditures, and the number and type of highway signs in place. The results of this inquiry are presented below.

### Record Keeping

Record keeping can be both costly and time consuming. It is difficult to know how detailed that records should be kept on an operation that is financed by public funds. Yet, if such records can be used to evaluate the cost-effectiveness of the operation, then such expenses may be well justified.

In the case of highway signs, the researchers were concerned that not enough data could be furnished by the various government agencies to perform a complete cost-effectiveness evaluation of small highway signs. Therefore, the respondents were asked several questions relating to their record keeping, and the results are shown in Table C-4. These results generally show that many of the respondents of government agencies do not keep detailed records on sign installation, maintenance, and replacement activities. The amount of record keeping varies among types of government agencies, as shown in Table C-5. Cities are more likely to maintain an inventory of signs in place than are the other types. On the other hand, state agencies are more likely to maintain records of roadside accidents than the other types.

Sign suppliers were asked the same questions concerning accident

Table C-4.

Type of Sign Records Kept by Respondent Government Agencies

| Question and Type of Response | Respondents | | | |
|---|---|---|---|---|
| | Number | | Percent | |
| Maintain Inventory of Signs in Place? | | | | |
| Yes, Categorized by: | 61 | | 55.0 | |
| Type or size | | 24 | | 21.6 |
| Type or size and other criteria | | 28 | | 25.3 |
| Other criteria than above | | 4 | | 3.6 |
| No criteria | | 5 | | 4.5 |
| No | 49 | | 44.1 | |
| No Response | 1 | | 0.9 | |
| Maintain Record of Sign Installation and Maintenance Activities and Costs? | | | | |
| Yes, giving: | 91 | | 82.0 | |
| Number repaired, labor required, etc. | | 68 | | 61.3 |
| Other data than above | | 23 | | 20.7 |
| No | 20 | | 18.0 | |
| No Response | 0 | | | |
| Maintain Record of Roadside Accidents?[a] | | | | |
| Yes, giving: | 55 | | 49.5 | |
| Type of sign impacted, damages, etc. | | 14 | | 39.6 |
| Other data than above | | 11 | | 9.9 |
| No | 54 | | 48.7 | |
| No Response | 2 | | 1.8 | |
| Total Respondents | 111 | | 100.0 | |

[a]Other than normal police records.

Table C-5.

Type of Sign Records Kept by Respondent Government Agencies, by Type of Respondent

| Question and Type of Response | Type of Respondent | | | |
|---|---|---|---|---|
| | State Agencies | Cities | Counties | Other[a] |
| | -Percent- | | | |
| Maintain Inventory of Signs in Place? | | | | |
| Yes | 48 | 68 | 44 | 60 |
| No | 52 | 32 | 56 | 40 |
| Maintain Record of Sign Installation and Maintenance Activities and Costs? | | | | |
| Yes | 79 | 86 | 94 | 60 |
| No | 21 | 14 | 16 | 40 |
| Maintain Record of Roadside Accidents?[b] | | | | |
| Yes | 60 | 43 | 38 | 40 |
| No | 40 | 57 | 62 | 60 |
| Total Respondents (Number) | (47) | (37) | (16) | (10) |

[a]Includes turnpikes and federal agencies.

[b]Other than normal police records.

records. One-third of responding suppliers maintain records of roadside accidents involving their products.

## Contracting of Sign Installation and Maintenance

The cost to install and maintain highway signs may vary according to who performs these activities. Therefore, questions were asked the governmental respondents to establish the extent to which they use contractors to perform these activities on new roads (including major reconstruction projects) and on existing roads under their jurisdiction. Table C-6 shows that very few of the governmental respondents contract out the maintenance of signs on existing roads. On the other hand, most of them contract out the installation of signs on new roads or major reconstruction projects. Over one-third of the respondents indicated that at least 80 percent of the signs installed by contractors on new roads are a part of a larger construction contract (Table C-6). However, most of the respondents indicated that their sign costs can readily be determined for new road signs installed as part of a larger construction contract.

## Installation and Maintenance Expenditures

Government agencies and sign contractors were asked several questions to establish the approximate levels of expenditures attributable to small sign installations and maintenance. Table C-7 shows the latest annual total maintenance expenditures of respondent government agencies and the proportion of such expenditures attributable to all signs and small signs. These results indicate that sign maintenance represents

Table C-6.

Percentage of Signs Installed or Maintained
By Contractors for Respondents of Government Agencies

| Question and Type of Response | Respondents | |
|---|---|---|
| | Number | Percent |
| Percentage of Signs on Existing Roads Maintained by a Contractor? | | |
| Less than 20% | 110 | 99 |
| 20% to 40% | 1 | 1 |
| 40% to 60% | 0 | 0 |
| 60% to 80% | 0 | 0 |
| 80% or more | 0 | 0 |
| No Response | 0 | 0 |
| Percentage of Signs on New Roads Installed by a Contractor? | | |
| Less than 20% | 58 | 52 |
| 20% to 40% | 6 | 5 |
| 40% to 60% | 3 | 3 |
| 60% to 80% | 5 | 4 |
| 80% or more | 34 | 30 |
| No Response | 5 | 6 |
| Percentage of New Road Signs Installed by Contractors as Part of Larger Contract? | | |
| Less than 20% | 30 | 27 |
| 20% to 40% | 3 | 3 |
| 40% to 60% | 4 | 3 |
| 60% to 80% | 2 | 2 |
| 80% or more | 42 | 38 |
| No Response | 30 | 27 |
| Costs Readily Determined for New Road Signs Installed as Part of Larger Contract? | | |
| Yes | 103 | 93 |
| No | 8 | 7 |
| No Response | 0 | 0 |
| Total Respondents | 111 | 100 |

Table C-7.

Total Maintenance Expenditures and Percentage Attributed to all Signs and Small Signs[a] for all Governmental Agencies

| Question and Type of Response | Respondents | |
|---|---|---|
| | Number | Percent |
| **Total Maintenance Expenditure?** | | |
| Less than $1,000,000 | 33 | 30 |
| $1,000,000 to $9,999,999 | 20 | 18 |
| $10,000,000 to $49,000,000 | 19 | 17 |
| $50,000,000 or more | 11 | 10 |
| No response | 28 | 25 |
| **Percentage of Maintenance Expenditure Devoted to Signs?** | | |
| Less than 20% | 44 | 40 |
| 20% to 40% | 22 | 20 |
| 40% to 60% | 6 | 5 |
| 60% to 80% | 3 | 3 |
| 80% or more | 3 | 3 |
| No response | 33 | 30 |
| **Percentage of Maintenance Expenditure Devoted to Small Signs?[b]** | | |
| Less than 20% | 42 | 38 |
| 20% to 40% | 17 | 15 |
| 40% to 60% | 2 | 2 |
| 60% to 80% | 2 | 2 |
| 80% or more | 15 | 14 |
| No response | 33 | 30 |
| Total Respondents | 111 | 100 |

[a]Expenditures for the immediate past fiscal year.

[b]Signs having panel areas of 50 square feet or less.

less than 40 percent of the total maintenance expenditures for most of these respondents. Also, the results indicate that maintenance expenditures attributable to small signs make up most of the total sign maintenance expenditures of these respondents. Since a major portion of the respondents' sign maintenance budgets are spent on small signs, careful study should be given to determine which sign support systems are the most cost-effective.

Sign contractors were asked to indicate their total dollar volume of business and the portion that is attributed to small sign installation. The results from five contractors indicate that small sign installation accounts for an average of 28 percent of their total business volume. Also, installation of new signs on new roads generates most of the receipts attributable to small signs. These results agree with those of Table C-6 which indicates that a significant percentage of the signs on new roads are installed by contractors. Nearly all of the contractors' business volume comes from contracts with state agencies for new and replacement sign installation.

## Conducting Cost-Effectiveness Analyses

The respondents were questioned concerning the use of cost-effectiveness analyses on their signing installations. Table C-8 shows this information by type of respondent. Generally, the results show that less than 20 percent of the respondents make use of cost-effectiveness analyses. State agencies are the least likely users, and counties are the most likely users.

Table C-8.

Extent of Use of Cost Effectiveness Analyses on Signing Installations by Respondent Government Agencies, by Type of Respondent

| Question and Response by Type of Respondent | Respondents Number | Percent |
|---|---|---|
| Cost Effectiveness Analyses Conducted on Signing Installations? | | |
| State Agencies | | |
| Yes | 5 | 10.4 |
| No | 41 | 85.4 |
| No Response | 2 | 4.2 |
| Cities | | |
| Yes | 5 | 13.5 |
| No | 31 | 83.8 |
| No Response | 1 | 2.7 |
| Counties | | |
| Yes | 7 | 43.8 |
| No | 8 | 50.0 |
| No Response | 1 | 6.2 |
| Other Agencies | | |
| Yes | 2 | 20.0 |
| No | 8 | 80.0 |
| All Respondents | | |
| Yes | 19 | 17.1 |
| No | 88 | 79.3 |
| No Response | 4 | 3.6 |

The respondents were also questioned concerning the interest rate used by their agency to compute the present value of future costs. As shown in Table C-9, most of the respondents failed to answer this question. The responses of those who answered indicate that there is a strong tendency to use a zero interest rate, especially the counties. Of those who use an interest rate, the most commonly used rate is in the 6 to 9 percent range. Economists are divided over the question of whether to use any interest rate in computing the present value of future costs of public projects. Use of an interest rate means that a charge is being made for the expected return on such funds if invested in the private sector. Most economists that advocate the use of an interest rate recommend a somewhat lower rate than is currently charged in the private money market.

## Sample Population of Small Signs

Questions were asked the respondent government agencies to determine the approximate number of road signs in place in the areas under their jurisdiction and to determine the portion of their signs that are of the small type and of the single post type. Table C-10 shows their responses to these questions. These results show that the respondent government agencies sampled are both large and small in terms of the number of signs in place. Also, a large majority of the respondents reported that 80 percent or more of their signs are of the small single post type. Such results confirm the need to evaluate small sign support systems.

Table C-9.

Interest Rate Used by Respondent Government Agencies to Compute Present Value of Future Costs, by Type of Respondent

| Question and Type of Response | Type of Respondents: State Agencies | Cities | Counties | Other | Total |
|---|---|---|---|---|---|
| | ---------- Number ---------- | | | | |
| Interest Rate Used to Compute Present Value of Future Costs? | | | | | |
| 0% to 6% | 4 | 0 | 4 | 2 | 10 |
| 6% to 9% | 6 | 1 | 1 | 1 | 9 |
| 9% to 12% | 2 | 1 | 1 | 2 | 6 |
| 12% to 15% | 1 | 1 | 2 | 0 | 4 |
| No Response | 35 | 34 | 8 | 5 | 82 |
| Total Respondents | 48 | 37 | 16 | 10 | 111 |

Table C-10.

Number of Signs in Place, Percentage of Small Type Signs, and Percentage of Small Signs Supported by Single Posts[a] for all Governmental Agencies

| Question and Type of Response | Respondents Number | Respondents Percent |
|---|---|---|
| Number of all Signs in Place? | | |
| Less than 20,000 | 19 | 17 |
| 20,000 - 49,999 | 16 | 15 |
| 50,000 - 99,999 | 17 | 15 |
| 100,000 - 199,999 | 14 | 13 |
| 200,000 or more | 21 | 19 |
| No Response | 24 | 21 |
| Percentage of All Signs of Small Type?[a] | | |
| Less than 20% | 1 | 1 |
| 20% to 40% | 0 | 0 |
| 40% to 60% | 2 | 2 |
| 60% to 80% | 11 | 10 |
| 80% or more | 90 | 81 |
| No Response | 7 | 5 |
| Percentage of Small Type Signs with Single Post Support System? | | |
| Less than 20% | 5 | 4 |
| 20% to 40% | 0 | 0 |
| 40% to 60% | 5 | 5 |
| 60% to 80% | 21 | 19 |
| 80% or more | 73 | 66 |
| No Response | 7 | 6 |
| Total Respondents | 111 | 100 |

[a]Signs having panel areas of 50 square feet or less are designated as small signs.

## C-3. GENERAL DATA ON SIGN SUPPORT SYSTEMS

An attempt was made to obtain enough data from the survey to define the criteria used for selecting sign support systems and to determine the characteristics and extent of usage of existing sign support systems.

### Criteria for Selecting Support Systems

The respondents were asked to rank several given factors that are generally considered important in the selection of a sign support system. They were permitted to add other factors to the list and rank them with the given factors. The rankings given each factor are shown in Table C-11. The results indicate that collision hazard to motorists receives first consideration by over 40 percent respondent government agencies in their selection of a sign support system. However, this factor was ranked only fourth by nearly 30 percent of the respondents, which means that these respondents consider other factors to be more important in the selection of a sign support system.

Since all the factors were ranked first by many of the respondents, the researchers suspected that the rankings might vary by type of respondent. The results presented in Table C-12 show this assumption to be true. Using a composite score to establish rankings, collision hazard to motorists was ranked first by the respondent state agencies, counties, federal agencies, and turnpikes (see footnote under Table C-12 for an explanation of the procedure). This factor is ranked fourth by respondent cities.

Table C-11

Factors Considered by Respondent Government Agencies to Be Important in Selection of a Sign Support System, Ranked in Order of Importance

| Rank of Importance Given Selection Factor | Respondents | |
|---|---|---|
| | Number | Percent |
| Availability of Materials for Replacement | | |
| First | 17 | 15 |
| Second | 28 | 25 |
| Third | 28 | 25 |
| Fourth | 31 | 28 |
| Fifth | 2 | 2 |
| No Response | 5 | 5 |
| Amount of Maintenance Required | | |
| First | 21 | 19 |
| Second | 29 | 26 |
| Third | 35 | 31 |
| Fourth | 21 | 19 |
| Fifth | 1 | 1 |
| No Response | 4 | 4 |
| Initial and Maintenance Costs | | |
| First | 26 | 24 |
| Second | 31 | 28 |
| Third | 29 | 25 |
| Fourth | 21 | 19 |
| Fifth | 0 | 0 |
| No Response | 4 | 4 |
| Collision Hazard to Motorist | | |
| First | 47 | 42 |
| Second | 14 | 12 |
| Third | 13 | 12 |
| Fourth | 30 | 27 |
| Fifth | 2 | 2 |
| No Response | 5 | 5 |
| Aesthetics or Others | | |
| First | 8 | 7 |
| Second | 3 | 3 |
| Third | 0 | 0 |
| Fourth | 1 | 1 |
| Fifth | 3 | 3 |
| No Response | 96 | 86 |
| Total Respondents | 111 | 100 |

Table C-12.

Ranking of Selected Factors Considered by Respondent Government Agencies to be Important in the Selection of a Sign Support System, by Type Respondent

| Sign Support Selection Factors | Ranking by Type of Respondent[a] | | | | |
|---|---|---|---|---|---|
| | State Agencies | Cities | Counties | Other | Total |
| Availability of Materials for Replacement | b | 3 | 4 | 3 | 4 |
| Amount of Maintenance Required | b | 1 | b | 2 | 3 |
| Initial and Maintenance Costs | 2 | 2 | b | 4 | 2 |
| Collision Hazard to Motorists | 1 | 4 | 1 | 1 | 1 |
| Total Respondents (Number)[c] | (46) | (35) | (15) | (9) | (105) |

[a]Based on a score computed by multiplying the rank given the factor by the number of respondents. The lowest aggregate score is ranked first, the next lowest score is ranked second, etc.

[b]Tie score between two of the factors.

[c]Six respondents failed to rank one or more of the above factors.

A cross-tabulation by regions also reveals different rankings of the selection factors by the respondents. As shown in Table C-13, all factors except availability of materials for replacement received a first place ranking by respondents of at least one region. The factor that was ranked first by most regions also was ranked low by two regions.

Sign suppliers were asked to rank the above four factors in the order of importance. The results shown below are very similar to those presented on the government agencies.

| Factor | Aggregate Ranking |
|---|---|
| Availability of materials for replacement | 4 |
| Amount of maintenance required | 2 |
| Initial and maintenance costs | 3 |
| Collision hazard to motorists | 1 |

These results are based on the rankings of eight suppliers. At least the first was ranked the same by responding government agencies and suppliers.

The prospective respondents were asked if they generally used different support systems for various functional classes of roadways (freeways, secondary, etc.) even for the same panel sizes. The results shown in Table C-14 indicate that most of the respondents do not. For those who do, the primary difference given is they place breakaway signs on freeways and yielding ("U" channel, pipe or wood) signs on primary and secondary roads.

The sign suppliers were also asked if they generally recommend different support systems for the various functional classes of roadways. Only 1 of the 9 respondents gave an affirmative answer.

Table C-13.

Ranking of Selected Factors Considered by Respondent Government Agencies to be Important in the Selection of a Sign Support System, by Region

| Sign Support Selection Factors | Ranking by Region [a,b] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 & 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Total |
| Availability of Materials for Replacement | 4 | 3 | c | 4 | c | 4 | 3 | 4 | 4 | 4 |
| Amount of Maintenance Required | c | 2 | c | 3 | c | 1 | 4 | 2 | 3 | 3 |
| Initial and Maintenance Costs | 3 | 1 | 2 | 2 | 4 | 3 | 2 | 1 | c | 2 |
| Collision Hazard to Motorist | c | 4 | 1 | 1 | 1 | 2 | 1 | 3 | c | 1 |
| Total Respondents (Number)[d] | (17) | (11) | (12) | (15) | (12) | (9) | (12) | (8) | (9) | (105) |

[a]Based on a score computed by multiplying the rank given the factor by the number respondents. The lowest aggregate score is ranked first; the next lowest score is ranked second, etc.

[b]See Figure 1 for location of regions.

[c]Tie score between two of the factors.

[d]Six respondents failed to rank one or more of the above factors.

Table C-14.

Use of Different Sign Support Systems with Same Panel Size for Various Functional Classes of Roadways by Respondent Government Agencies

| Type of Response with Reason | Respondents | | | |
|---|---|---|---|---|
| | Number | | Percent | |
| Use Different Support Systems? | | | | |
| Yes, Use: | 23 | | 20.7 | |
| Breakaway on freeways and "U" Channel or pipe elsewhere | | 6 | | 5.4 |
| Breakaway on freeways or arterials and primarily wood elsewhere | | 2 | | 1.8 |
| Steel on freeways and mostly wood elsewhere | | 5 | | 4.5 |
| Tubular aluminum on freeways and steel or wood elsewhere | | 2 | | 1.8 |
| Differences not clearly delineated | | 8 | | 7.2 |
| No | 88 | | 79.3 | |
| Total Respondents | 111 | | 100.0 | |

## Small Sign Support Systems in Use

The prospective respondent government agencies were first asked to describe each of the small sign support systems in use, giving the cross-sectional shape, type of material, size, type of base design, number of posts used and the percentage of use of each system. These findings are presented below.

### Materials and Cross-Sectional Shapes of Posts

The different types of materials and cross-sectional shapes of the support posts being used by the respondents are reported separately for single and multiple post signs.

Single Post Signs - The percentages of respondents using various types of single post signs are shown in Table C-15 by type of respondent. The results indicate that steel "U" (single) posts are used by the highest percentage of respondents regardless of type respondent. Also, round or oval steel pipe posts, square or rectangular wood posts, and square or rectangular steel tube posts are used by at least 30 percent of the respondents. However, there is considerable variation in the use of the last three types of posts among type of respondents, especially the wood posts. A high percentage of state agencies, turnpike authorities, and federal agencies make use of square or rectangular wood posts. On the other hand, a low percentage of cities and counties use such posts.

The percentages of respondents using single posts of different materials and shapes vary even more widely by region, as is seen in Table C-16. For instance, steel "U" (single) posts rank first in Regions 1 and 2 combined, 3, 4, 5, and 7; round steel pipe posts rank

Table C-15.

Respondents Using Single Post Signs of Different Types of Materials and Cross-Sectional Shapes, by Type of Respondent

| Type of Material/ Cross-Sectional Shape | Type of Respondents | | | | |
|---|---|---|---|---|---|
| | State Agencies | Cities | Counties | Other | Total |
| | - - - - -Percent of Respondents- - - - - | | | | |
| Steel | | | | | |
| "U" Single | 63 | 70 | 94 | 50 | 69 |
| "U" Back to Back | 4 | 0 | 0 | 0 | 2 |
| Square or Rectangular Tube | 31 | 41 | 38 | 20 | 34 |
| Round or Oval Pipe | 40 | 62 | 19 | 20 | 42 |
| Tapered Pipe | 2 | 0 | 0 | 0 | 1 |
| Beam (I, S, W, or H) | 4 | 0 | 0 | 10 | 5 |
| Angle (Z) | 2 | 3 | 0 | 0 | 2 |
| Aluminum | | | | | |
| "U" Single | 4 | 5 | 0 | 0 | 4 |
| Round or Oval Pipe | 10 | 8 | 13 | 10 | 10 |
| Beam (I, S, W, or H) | 4 | 0 | 6 | 0 | 3 |
| Angle (Z) | 2 | 0 | 0 | 0 | 1 |
| Wood | | | | | |
| Square or Rectangular | 58 | 19 | 13 | 70 | 40 |
| Round | 4 | 0 | 0 | 20 | 4 |
| Combination | 0 | 0 | 0 | 10 | 1 |
| Plastic | | | | | |
| Round or Oval Pipe | 0 | 5 | 0 | 0 | 2 |
| Total Respondents (Number) | (48) | (37) | (16) | (10) | (111) |

Table C-16.

Respondents Using Single Post Signs of Different Types of Materials and Cross-Sectional Shapes, by Region

| Type of Material/ Cross-Sectional Shape | Region | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1&2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | - - - - - - Percent of Respondnets - - - - - - | | | | | | | | |
| Steel | | | | | | | | | |
| "U" Single | 83 | 91 | 75 | 93 | 43 | 83 | 50 | 50 | 22 |
| "U" Back to Back | 0 | 0 | 0 | 13 | 0 | 0 | 0 | 0 | 0 |
| Square or Rectangular Tube | 28 | 9 | 50 | 27 | 43 | 33 | 42 | 63 | 22 |
| Round Pipe | 11 | 45 | 33 | 0 | 71 | 50 | 75 | 50 | 55 |
| Tapered Pipe | 0 | 9 | 0 | 20 | 0 | 0 | 0 | 0 | 0 |
| Beam (I, S, W, or H) | 0 | 9 | 0 | 0 | 14 | 8 | 8 | 13 | 0 |
| Angle (Z) | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 |
| Aluminum | | | | | | | | | |
| "U" Single | 0 | 9 | 8 | 13 | 0 | 0 | 0 | 0 | 0 |
| Square or Rectangular Tube | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 0 |
| Round Pipe | 22 | 0 | 17 | 7 | 0 | 8 | 8 | 13 | 11 |
| Beam (I, S, W, or H) | 11 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 |
| Angle (Z) | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Wood | | | | | | | | | |
| Square or Rectangular | 22 | 45 | 42 | 27 | 21 | 50 | 58 | 25 | 78 |
| Round | 0 | 0 | 0 | 7 | 0 | 0 | 25 | 0 | 0 |
| Combination | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 0 |
| Plastic | | | | | | | | | |
| Round Pipe | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 | 11 |
| Total Respondents (Number) | (18) | (11) | (12) | (15) | (14) | (12) | (12) | (8) | (9) |

first in Regions 6 and 8, square or rectangular steel tube posts rank first in Region 9; and square or rectangular wood posts rank first in Region 10. The percentages of respondents using round steel pipe and round or rectangular wood posts are greatest in the Western States.

Perhaps a better measure of the extent of usage of posts made of different materials and shapes is the estimated percentage of small signs in-place using each type of post. Such percentages are biased to a limited extent because several respondents failed to give enough data to make such estimates. As can be seen in Table C-17, over one-third of all small single post signs have steel "U" (single) type posts. Square or rectangular wood posts are the next most commonly used, followed by round or oval steel pipe posts. Again, there is considerable variation in the use of each type of post among the different types of respondents (Table C-17). Almost half of the signs used by respondent cities and counties have the steel "U" (single) type of post, but less than 30 percent of the state agency signs are this type of post.

Table C-18 shows that there is considerable variation in the usage of each type of post among regions of the country. Respondents of Region 3 use the steel "U" (single) type of post for nearly three-fourths of their small single post signs, but respondents in Region 10 use this type of post for less than one percent of their single post signs. Respondents in Regions 7, 9 and 10 use square or rectangular wood posts for nearly three-fourths of their single post signs.

<u>Multiple Post Signs</u> - The percentages of respondents using various types of multiple post signs are shown in Table C-19. As in the case

Table C-17.

Extent of Use of Single Post Signs of Different Types of Materials and Cross-Sectional Shapes, by Type of Respondent[a]

| Type of Material/ Cross-Sectional Shape | Type of Respondents | | | | |
|---|---|---|---|---|---|
| | State Agencies | Cities | Counties | Other | Total |
| | - - - - - - Percent of Signs - - - - - | | | | |
| Steel | | | | | |
| "U" Single | 29.8 | 48.6 | 48.3 | 36.6 | 34.0 |
| "U" Back to Back | 1.2 | 0.0 | 0.0 | 0.0 | 0.9 |
| Square of Rectangular Tube | 13.6 | 10.1 | 13.4 | 2.9 | 12.7 |
| Round or Oval Pipe | 25.3 | 31.6 | 3.3 | 12.0 | 24.8 |
| Tapered Pipe | b | 0.0 | 0.0 | 0.0 | b |
| Beam (I, S, W, or H) | 0.2 | 0.0 | 0.0 | b | 0.2 |
| Angle (Z) | b | 1.3 | 0.0 | 0.0 | 0.2 |
| Aluminum | | | | | |
| "U" Single | c | c | 0.0 | 0.0 | c |
| Round or Oval Pipe | 0.5 | 1.7 | 2.5 | 0.2 | 0.8 |
| Beam (I, S, W, or H) | c | b | c | 0.0 | 0.1 |
| Angle (Z) | b | 0.0 | 0.0 | 0.0 | b |
| Wood | | | | | |
| Square or Rectangular | 28.9 | 6.3 | 32.5 | 38.0 | 25.6 |
| Round | 0.5 | 0.0 | 0.0 | 4.2 | 0.5 |
| Combination | 0.0 | 0.0 | 0.0 | 6.1 | 0.1 |
| Plastic | | | | | |
| Round Pipe | 0.0 | 0.4 | 0.0 | 0.0 | 0.1 |
| Total Single Post Signs (000) | (7,901) | (1,699) | (576) | (230) | (10,406) |

[a]Based on the number of small signs in place, as reported by the respondents. This table does not represent all of the signs in place because a few respondents either did not estimate the percentage of usage of certain types of signs or did not report enough data to estimate the small sign population.

[b]Number of signs not reported.

[c]Negligible

Table C-18.

Extent of Use of Single Post Signs of Different Types of Materials and Cross-Sectional Shapes, by Region[a]

| Type of Material/ Cross-Sectional Shape | Region | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1&2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | - - - - - - - - - - - - Percent of Signs | | | | | | | | - - - - - - - - - - - - - - |
| Steel | | | | | | | | | |
| "U" Single | 33.0 | 73.9 | 44.9 | 53.5 | 19.2 | 21.0 | 17.5 | 11.4 | 0.7 |
| "U" Back to Back | 0.0 | 0.0 | 0.0 | 6.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Square or Rectangular Tube | 38.6 | 17.6 | 18.4 | 14.8 | 2.3 | b | 28.1 | 1.7 | 5.2 |
| Round or Oval Pipe | 5.5 | 3.6 | 3.9 | 2.7 | 76.7 | 4.2 | 9.4 | 8.8 | 14.9 |
| Beam (I, S, W, or H) | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 1.3 | 0.0 | 0.3 | 0.0 |
| Angle (Z) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.9 |
| Aluminum | | | | | | | | | |
| "U" Single | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Round or Oval Pipe | 2.8 | 0.0 | 1.3 | 0.0 | 0.0 | 0.0 | 0.1 | 8.8 | 0.5 |
| Beam (I, S, W, or H) | 0.7 | 0.0 | 0.0 | b | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Wood | | | | | | | | | |
| Square or Rectangular | 19.4 | 4.9 | 31.5 | 22.2 | 1.2 | 73.5 | 30.4 | 68.9 | 73.8 |
| Round | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 14.5 | 0.0 | 0.0 |
| Combination | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| Plastic | | | | | | | | | |
| Round Pipe | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 1.0 |
| Total all Signs (000) | (1,044) | (1,001) | (1,817) | (1,447) | (2,855) | (995) | (343) | (327) | (576) |

[a]See Footnote "a" in Table 17.

[b]Negligible

Table C-19.

Respondents Using Multiple Post Signs of Different Types of Materials and Cross-Sectional Shapes, by Type of Respondent

| Type of Material/ Cross-Sectional Shape | Type of Respondent | | | | |
|---|---|---|---|---|---|
| | State Agencies | Cities | Counties | Other | Total |
| | - - - -Percent of Respondents- - - - - - | | | | |
| Steel | | | | | |
| "U" Single | 40 | 35 | 75 | 10 | 41 |
| "U" Back to Back | 4 | 0 | 6 | 0 | 3 |
| Square or Rectangular Tube | 23 | 11 | 6 | 20 | 16 |
| Round or Oval Pipe | 13 | 10 | 6 | 10 | 12 |
| Tapered Pipe | 2 | 0 | 0 | 0 | 1 |
| Beam (I, S, W, or H) | 48 | 0 | 0 | 30 | 24 |
| Angle (Z) | 2 | 2 | 0 | 0 | 2 |
| Aluminum | | | | | |
| "U" Single | 2 | 3 | 0 | 0 | 2 |
| Round or Oval Pipe | 6 | 3 | 6 | 10 | 5 |
| Beam (I, S, W, or H) | 6 | 0 | 0 | 0 | 3 |
| Wood | | | | | |
| Square or Rectangular | 52 | 14 | 0 | 70 | 34 |
| Round | 6 | 0 | 0 | 10 | 4 |
| Combination | 2 | 0 | 0 | 10 | 2 |
| Total Respondents (Number) | (48) | (37) | (16) | (10) | (111) |

of single post signs, steel "U" (single) posts are used by the highest percentage of respondents. The next highest percentage use square or rectangular wood posts followed by steel beam (I, S, W, or H) posts. A comparison of Tables C-15 and C-19 reveals that the respondents do not use as many different types of multiple post signs as they do of single post signs. Also, the percentage of respondents using each type of post is usually greater for single post signs than for multiple post signs.

As in the case of single post signs, the percentage of respondents using each type of post varies considerably by type of respondent (Table C-19). A high percentage of state agencies, turnpike authorities, and federal agencies use square or rectangular posts. In contrast, a low percentage of cities and counties use this type of post. The same pattern of use is seen for steel beam posts.

The percentage of respondents using multiple posts of the same materials and shape varies considerably from region to region, as shown in Table C-20. For example, Region 10 does not use steel "U" (single) posts for multiple post signs while all other regions use such posts.

The extent of use (percentage) of multiple signs of different materials and cross-sectional shapes is shown in Table C-21. Again, such percentages are based on the estimated number of small signs in-place of each type. As can be seen, the percentage of each type of multiple post sign varies considerably by type of respondent. In the case of counties, almost all of the multiple post signs are of the steel "U" (single) type, whereas, this type makes up a very small percentage of the signs used by cities.

Last, the variation in usage of each type of multiple post sign on a regional basis can be seen in Table C-22.

Sizes of Posts

The results of the survey reveal the respondent's use various sizes of posts for their in-place signs. Tables C-23 to C-27 show the extent use of each size of post by shape and type of material for both single and multiple post signs and by type of respondent. The extent of usage is based on the percentage of signs in-place as reported by the respondents. However, the percentages and totals shown in these tables do not reflect all of the signs in-place of a certain type due to missing data. Also, some of the respondents reported size ranges instead of specific sizes for a cross-sectional shape. Therefore, the extent of usage of certain sizes is not very precise. But the data presented in the tables gives a reasonably good indication of the most commonly used sizes for a particular type of post.

A study of the data presented in Tables C23 through C27 reveals that the extent of usage of a particular size of post varies by type of respondent, type of sign and type of material. For instance, state agencies use posts of the larger sizes more frequently than do the other government agencies. One exception to this is wood posts where the reverse is true. Also, there is a tendency for posts of the smaller sizes to be used more frequently for single post signs than for multiple post

Table C-20.

Respondents Using Multiple Post Signs of Different Types of Materials and Cross-Sectional Shapes, By Region

| Type of Material/ Cross-Sectional Shape | Region 1 & 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|
| | -Percent of Respondents- | | | | | | | | |
| Steel | | | | | | | | | |
| "U" Single | 44 | 45 | 75 | 53 | 36 | 42 | 17 | 38 | 0 |
| "U" Back to Back | 0 | 0 | 8 | 13 | 0 | 0 | 0 | 0 | 0 |
| Square or Rectangular Tube | 11 | 9 | 17 | 13 | 29 | 0 | 25 | 38 | 11 |
| Round or Oval Pipe | 0 | 0 | 0 | 7 | 29 | 7 | 25 | 33 | 22 |
| Tapered Pipe | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Beam (I, S, W, or H) | 11 | 36 | 42 | 13 | 20 | 17 | 33 | 13 | 22 |
| Angle (Z) | 6 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Aluminum | | | | | | | | | |
| "U" Single | 0 | 0 | 8 | 7 | 0 | 0 | 0 | 0 | 0 |
| Round or Oval Pipe | 22 | 0 | 8 | 0 | 0 | 0 | 0 | 13 | 0 |
| Beam (I, S, W, or H) | 11 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 |
| Wood | | | | | | | | | |
| Square or Rectangular | 22 | 45 | 33 | 27 | 14 | 50 | 50 | 25 | 44 |
| Round | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 13 | 0 |
| Combination | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 0 |
| Total Respondents (Number) | (18) | (11) | (12) | (15) | (14) | (12) | (12) | (8) | (9) |

Table C-21.

Extent of Use of Multiple Post Signs of Different Types of Materials and Cross-Sectional Shapes by Type of Respondent[a]

| Type of Material/ Cross-Sectional Shape | Type of Respondents | | | | |
|---|---|---|---|---|---|
| | State Agencies | Cities | Counties | Other | Total |
| | - - - - - - Percent of Signs - - - - - - | | | | |
| Steel | | | | | |
| "U" Single | 32.4 | 1.8 | 97.8 | 4.5 | 29.7 |
| "U" Back to Back | 3.4 | 0.0 | b | 0.0 | 3.0 |
| Square or Rectangular Tube | 7.0 | 11.1 | b | 2.2 | 7.2 |
| Round or Oval Pipe | 4.9 | 81.3 | b | b | 12.4 |
| Tapered Pipe | b | 0.0 | 0.0 | 0.0 | b |
| Beam (I, S, W, or H) | 16.7 | 0.0 | 0.0 | 3.8 | 14.6 |
| Angle (Z) | b | c | 0.0 | 0.0 | c |
| Aluminum | | | | | |
| "U" Single | c | b | 0.0 | 0.0 | c |
| Round or Oval Pipe | 0.7 | 2.3 | 2.2 | 0.3 | 0.9 |
| Beam (I, S, W, or H) | 6.6 | 0.0 | 0.0 | 0.0 | 5.8 |
| Wood | | | | | |
| Square or Rectangular | 27.4 | 3.5 | 0.0 | 53.6 | 25.1 |
| Round | 0.9 | 0.0 | 0.0 | 15.5 | 1.0 |
| Combination | b | 0.0 | 0.0 | 20.1 | 0.3 |
| Total Multiple Post Signs (000) | (2,126) | (245) | (27) | (39) | (2,436) |

[a]See Footnote "a" in Table 17.

[b]Number of signs not reported.

[c]Negligible

Table C-22.

Extent of Use of Multiple Post Signs of Different Types of Materials and Cross-Sectional Shapes, by Region[a]

| Type of Material/ Cross-Sectional Shape | Region | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 & 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | - - - - - - - - - - - - - -Percent of Signs - - - - - - - - - - - - - | | | | | | | | |
| Steel | | | | | | | | | |
| "U" Single | 6.4 | 63.5 | 31.7 | 40.8 | 21.5 | 1.9 | c | 34.0 | 0.0 |
| "U" Back to Back | 0.0 | 0.0 | b | 12.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Square or Rectangular Tube | 25.1 | 14.6 | 1.1 | 9.7 | 1.0 | 0.0 | 26.1 | 3.7 | 2.0 |
| Round or Oval Pipe | 0.0 | 0.0 | 0.0 | b | 70.9 | 3.7 | 0.9 | b | 1.0 |
| Tapered Pipe | 0.0 | b | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Beam (I, S, W, or H) | 37.4 | 0.8 | 27.8 | 4.6 | 2.4 | 6.2 | 7.2 | 4.1 | 38.7 |
| Angle (Z) | b | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Aluminum | | | | | | | | | |
| "U" Single | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Round or Oval Pipe | 7.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 7.3 | 0.0 |
| Beam (I, S, W, or H) | 1.2 | 0.0 | 18.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Wood | | | | | | | | | |
| Square or Rectangular | 22.9 | 21.0 | 20.5 | 32.0 | 2.4 | 88.2 | 36.0 | 46.1 | 58.3 |
| Round | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 29.8 | 4.8 | 0.0 |
| Combination | 0.0 | 0.0 | 0.0 | 0.0 | 1.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total All Signs (000) | (230) | (191) | (732) | (572) | (420) | (105) | (73) | (78) | (35) |

[a]See Footnote "a" in Table 17.

[b]Number of signs not reported.

[c]Negligible.

Table C-23.

Extent of Use of Different Sizes of "U" Posts, by Type of Sign, Type of Material, Type of Respondent[a]

| Type of Respondent/ Sign/Material | Size (Pounds per Foot) | | | | | Total Signs |
|---|---|---|---|---|---|---|
| | Under 2.00 | 2.00-2.99 | 3.00-3.99 | 4.00 or Over | Other[b] | |
| | ------ Percent of Signs ------ | | | | | (Number) |
| State Agencies | | | | | | |
| Single Post Signs | | | | | | |
| Steel "U" Single | 5.8 | 34.3 | 13.8 | 13.8 | 32.4 | (2,345,114) |
| Steel "U" Back to Back | 0.0 | 0.0 | 0.0 | 100.0 | 0.0 | (93,938) |
| Aluminum "U" Single[d] | | | | | 100.0 | (540) |
| Multiple Post Signs | | | | | | |
| Steel "U" Single | 3.5 | 21.2 | 14.9 | 31.0 | 29.4 | (688,883) |
| Steel "U" Back to Back | 0.0 | 0.0 | 0.0 | 100.0 | 0.0 | (73,272) |
| Aluminum "U" Single[d] | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 | (360) |
| Other Government Agencies | | | | | | |
| Single Post Signs | | | | | | |
| Steel "U" Single | 0.0 | 61.6 | 12.9 | 0.2 | 25.3 | (842,720) |
| Aluminum "U" Single[d] | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | (363) |
| Multiple Post Signs | | | | | | |
| Steel "U" Single | 0.0 | 89.9 | 6.3 | 0.1 | 3.6 | (24,268) |
| Aluminum "U" Single[d] | 0.0 | 0.0 | b | 0.0 | 0.0 | (c) |

[a]Some of percentages and totals do not reflect all of the signs in place of a certain type due to missing data.

[b]Includes those stated in size ranges that overlap the above with most falling in a 2.00-3.00 pounds per square foot range.

[c]Number of signs not reported.

[d]See footnote "f", Table IV-C-1 regarding sizes of aluminum U-posts.

Table C-24.

Extent of Use of Different Sizes of Round Posts, by Type of Sign, Type of Material, and Type of Respondent[a]

| Type of Respondent/ Sign/Material | Size (Inches in Diameter) | | | | Total Signs |
|---|---|---|---|---|---|
| | 2.00- 2.99 | 3.00- 3.99 | 4.00 or Over | Other[b] | |
| | - - - - Percent of Signs - - - - | | | | (Number) |
| State Agencies | | | | | |
| Single Post Signs | | | | | |
| Steel Pipe | 12.8 | 32.3 | 0.5 | 54.4 | (1,999,624) |
| Aluminum Pipe | 0.0 | 0.0 | 0.0 | 100.0 | (40,227) |
| Wood Post | 0.0 | 0.0 | 0.0 | 100.0 | (42,960) |
| Multiple Post Signs | | | | | |
| Steel Pipe | 95.8 | 0.0 | 0.0 | 4.2 | (103,326) |
| Aluminum Pipe | 0.0 | 0.0 | 0.0 | 100.0 | (15,880) |
| Wood Post | 0.0 | 0.0 | 0.0 | 100.0 | (15,840) |
| Other Agencies | | | | | |
| Single Post Signs | | | | | |
| Steel Pipe | 98.3 | 1.2 | 0.0 | 0.5 | (555,605) |
| Aluminum Pipe | 66.0 | 0.0 | 1.1 | 32.9 | (44,374) |
| Wood Post | 0.0 | 0.0 | 30.2 | 69.8 | (9,605) |
| Multiple Post Signs | | | | | |
| Steel Pipe | 100.0 | c | 0.0 | c | (199,049) |
| Aluminum Pipe | 89.1 | 9.3 | 1.6 | 0.0 | (6,401) |
| Wood Post | 0.0 | 0.0 | 1.0 | 100.0 | (5,990) |

[a]Some of the totals and percentages do not reflect all of the signs in place of a particular type due to missing data.

[b]Includes those stated in size ranges that overlap the above, with most falling in a 2.00-5.00 inches in diameter range.

[c]Number of signs not reported.

Table C-25.

Extent of Use of Different Sizes of Square Posts by Type of Sign, Type of Material, and Type of Respondent[a]

| Type of Respondent/ Sign/Material | Size (Inches Square) Under 2.00 | 2.00- 2.99 | 3.00- 3.99 | 4.00- 4.99 | 5.00 or Over | Other[b] | Total Signs |
|---|---|---|---|---|---|---|---|
| | - - - - - - - | Percent of | Signs | - - - - - - - | | | (Number) |
| State Agencies | | | | | | | |
| Single Post Signs | | | | | | | |
| Steel Tube[c] | 37.8 | 9.6 | 0.9 | 0.0 | 0.0 | 51.7 | (1,060,783) |
| Wood Post | 0.0 | 0.0 | 0.0 | 45.7 | 0.9 | 53.4 | (1,485,408) |
| Multiple Post Signs | | | | | | | |
| Steel Tube[c] | 39.5 | 1.8 | 0.0 | 0.0 | 0.0 | 58.7 | (147,716) |
| Wood Post | 0.0 | 0.0 | 0.0 | 66.4 | 4.1 | 29.5 | (235,245) |
| Other Agencies | | | | | | | |
| Single Post Signs | | | | | | | |
| Steel Tube[c] | 26.9 | 19.5 | 0.0 | 0.0 | 0.0 | 53.6 | (254,837) |
| Wood Post | 0.0 | 0.0 | 0.0 | 78.3 | 0.1 | 21.6 | (373,435) |
| Multiple Post Signs | | | | | | | |
| Steel Tube[c] | 29.5 | 67.4 | 0.0 | 0.0 | 0.0 | 3.1 | (28,090) |
| Wood Post | 0.0 | 0.0 | 0.0 | 67.4 | 0.0 | 32.6 | (16,980) |

[a]Some of the totals and percentages do not reflect all of the signs in place of a particular type due to missing data.

[b]Includes those stated in size ranges that overlap the above, with most falling in a 1.50 - 2.50 inches square range.

[c]Includes perforated and nonperforated tubing.

Table C-26.

Extent of Use of Different Sizes of Rectangular Posts, by Type of Sign, Type of Material, and Type of Respondent[a]

| Type of Respondent/ Sign/Material | Size (Inches of Rectangle) | | | | Total Signs |
|---|---|---|---|---|---|
| | 2x3-3x4 | 4x6 | 6x8-6x10 | Other[b] | |
| | - - - - Percent of Signs - - - - - | | | | (Number) |
| State Agencies | | | | | |
| Single Post Signs | | | | | |
| Steel Tube[c] | 100.0 | 0.0 | 0.0 | 0.0 | (10,718) |
| Wood Post | 0.0 | 20.3 | 2.1 | 77.6 | (797,020) |
| Multiple Post Signs | | | | | |
| Wood Post | 0.0 | 58.9 | 1.8 | 39.3 | (316,056) |
| Other Agencies | | | | | |
| Single Post Signs | | | | | |
| Wood Post | 0.0 | 19.4 | 3.2 | 77.4 | (9,043) |
| Multiple Post | | | | | |
| Wood Post | 0.0 | 16.2 | 26.8 | 57.0 | (12,088) |

[a]Some of the totals and percentages do not reflect all of the signs in place of a particular type due to missing data.

[b]Includes those stated in size ranges that overlap the above.

[c]Includes perforated and nonperforated posts.

Table C-27.

Extent of Use of Different Sizes of Beam Posts, by Type of Sign, Type of Material, and Type of Respondent[a]

| Type of Respondent/ Sign/Material | Size (Nominal Depth and Weight)[b] 3x5.7-4x7.7 | 5x10.0-6x12.0 | 6x12.5-8x24.0 | 8x24.0-or Over | Other[c] | Total Signs |
|---|---|---|---|---|---|---|
| | - - - - - - - Percent of Signs | | | | - - - - - - - | (Number) |
| State Agencies | | | | | | |
| Single Post Signs | | | | | | |
| Steel Beam (I, S, W, or H) | 27.8 | 72.2 | 0.0 | 0.0 | 0.0 | (17,955) |
| Aluminum Beam (I, S, W, or H) | 0.0 | 0.0 | 0.0 | 0.0 | d | (6,840) |
| Steel Angle (Z) | 0.0 | 0.0 | 0.0 | 0.0 | d | d |
| Multiple Post Signs | | | | | | |
| Steel Beam (I, S, W, or H) | 32.4 | 4.2 | 1.8 | 2.7 | 59.0 | (353,505) |
| Aluminum Beam (I, S, W, or H) | 2.0 | 0.0 | 0.0 | 0.0 | 98.0 | (140,760) |
| Steel Angle (Z) | 0.0 | 0.0 | 0.0 | 0.0 | b | d |
| Other Agencies | | | | | | |
| Single Post Signs | | | | | | |
| Steel Beam (I, S, W, or H) | 0.0 | 0.0 | 0.0 | 0.0 | d | d |
| Multiple Post | | | | | | |
| Steel Beam (I, S, W, or H) | 0.0 | 0.0 | 0.0 | 0.0 | d | d |

[a]Some of the totals and percentages do not reflect all of the signs in place of a certain type due to missing data.

[b]For say a size of 3x5.7, the first value (3) indicates the nominal depth in inches while the second value (5.7) indicates the weight in pounds per foot.

[c]Includes those stated in size ranges that overlap the above.

[d]Number of signs not reported.

signs. This is especially true with round posts. Last, the larger posts are more likely to be made of aluminum or wood than of steel.

## C-4. DETAILED DATA ON THE MOST WIDELY USED SIGN SUPPORT SYSTEMS

After being asked to furnish data on all of their sign support systems, the responding government agencies were asked to furnish detailed design and cost data on their three most widely used single post systems and their three most widely used multiple post systems. Also, they were requested to rank their single post sign systems and multiple post sign systems according to extent of use.

A sign system is one in which the respondents identified as having a specific set of support post, stub post, footing, and panel characteristics.

### Description and Extent of Use

The description and extent of use of each component of each sign system is given below in the following order: support post, stub post, footing, and sign panel. The description is keyed to the type of material and cross-sectional shape of the support post(s). The extent of use is based primarily on the number of sign systems reported.

#### Support Post

The following types of information were obtained on the support post(s) of each sign system: material, cross-sectional shape, size, design life, hinge usage, extent tested, whether it met AASHTO standards, rank in use, and location of use. Data on the extent tested and whether they meet AASHTO standards are presented in a separate section of the report.

Materials and Cross-Sectional Shape - The total number of single post sign systems is shown in parentheses in Table C-28. The extent of use of each type of support post can easily be ascertained. By far the two most widely used systems have either steel "U" single support posts or wood square or rectangular support posts. According to Table C-29, the two most widely used multiple post systems have these types of support posts with systems having wood posts being more extensively used than systems having steel posts.

Tables C-28 and C-29 also show the extent of use of each system by type of respondent. Considerable variation in usage of both the single post and multiple post systems can be seen. Several systems are reported by only one type of respondent, particularly those systems using beam and tube type posts.

The results of ranking the three most widely used sign systems according to type of support post used are shown in Tables C-30 and C-31. For example, of the 87 systems using steel "U" single posts, 56.4 percent were ranked first in use, 31.0 percent were ranked second, and 12.6 percent were ranked third. These results indicate that sign systems with steel "U" single type support posts are extensively used.

The respondents were asked to indicate where they use each sign system by giving the number of signs in-place in urban and rural areas. The results for both single and multiple post signs are shown in Table C-32. The number of each type of sign is reported in parentheses. The percentages indicate which types of sign systems are used predominately in rural or urban areas. A comparison of signs with single posts and multiple posts with the same type of post indicates that if

Table C-28.

Extent of Use of the Most Widely Used Single Post Sign Systems, by Type of Post and Type of Respondent[a]

| Type of Post Material/ Cross-Sectional Shape | Type of Respondent | | | | Total |
|---|---|---|---|---|---|
| | State Agencies | Cities | Counties | Other | Systems |
| | - - - - - Percent of Systems - - - - - | | | | (Number) |
| Steel | | | | | |
| "U" Single | 37.9 | 34.5 | 20.7 | 6.9 | (87) |
| "U" Back to Back | 66.7 | 33.3 | 0.0 | 0.0 | (3) |
| Square or Rect. Tube | 45.7 | 40.0 | 14.3 | 0.0 | (35) |
| Round or Oval Pipe | 35.9 | 59.0 | 5.1 | 0.0 | (39) |
| Beam (I,S,W, or H) | 100.0 | 0.0 | 0.0 | 0.0 | (5) |
| Aluminum | | | | | |
| "U" Single | 100.0 | 0.0 | 0.0 | 0.0 | (1) |
| Square or Rect. Tube | 0.0 | 100.0 | 0.0 | 0.0 | (1) |
| Round or Oval Pipe | 45.5 | 36.3 | 9.1 | 9.1 | (11) |
| Beam (I,S,W, or H) | 100.0 | 0.0 | 0.0 | 0.0 | (1) |
| Wood | | | | | |
| Square or Rectangular | 65.0 | 11.7 | 6.7 | 16.6 | (60) |
| Round | 33.3 | 0.0 | 0.0 | 66.7 | (3) |
| Plastic | | | | | |
| Pipe | 0.0 | 100.0 | 0.0 | 0.0 | (1) |

[a]A sign system is one in which the respondents identified in the questionnaire as having a specific set of support-post, stub-post, footing, and panel characteristics.

Table C-29.

Extent of Use of the Most Widely Used Multiple Post Sign Systems, by Type of Post and Type of Respondent[a]

| Type of Post Material/ Cross-Sectional Shape | Type of Respondent | | | | Total |
|---|---|---|---|---|---|
| | State Agencies | Cities | Counties | Other | Systems |
| | - - - - -Percent of Systems- - - - - | | | | (Number) |
| Steel | | | | | |
| "U" Single | 50.0 | 23.8 | 23.8 | 2.4 | (42) |
| "U" Back to Back | 50.0 | 25.0 | 25.0 | 0.0 | (4) |
| Square or Rect. Tube | 43.8 | 31.2 | 25.0 | 0.0 | (16) |
| Round or Oval Pipe | 46.2 | 46.2 | 7.6 | 0.0 | (13) |
| Beam (I,S,W, or H) | 100.0 | 0.0 | 0.0 | 0.0 | (27) |
| Angle (Z) | 0.0 | 0.0 | 0.0 | 100.0 | (1) |
| Aluminum | | | | | |
| "U" Single | 50.0 | 0.0 | 50.0 | 0.0 | (2) |
| Square or Rect. Tube | 0.0 | 100.0 | 0.0 | 0.0 | (1) |
| Round or Oval Pipe | 44.4 | 22.2 | 22.2 | 11.2 | (9) |
| Beam (I,S,W, or H) | 100.0 | 0.0 | 0.0 | 0.0 | (4) |
| Wood | | | | | |
| Square or Rectangular | 69.1 | 9.1 | 0.0 | 21.8 | (55) |
| Round | 33.3 | 0.0 | 0.0 | 66.7 | (3) |

[a]A sign system is one in which the respondents identified in the questionnaire as having a specific set of support-post, stub-post, footing, and panel characteristics.

Table C-30.

Rank in Use of the Most Widely Used Single Post Sign Systems, by Type of Post[a]

| Type of Post Material/ Cross-Sectional Shape | Rank in Use First | Second | Third | Total Systems |
|---|---|---|---|---|
| | - - - Percent of Systems - - - | | | (Number) |
| Steel | | | | |
| "U" Single | 56.4 | 31.0 | 12.6 | (87) |
| "U" Back to Back | 0.0 | 33.3 | 66.7 | (3) |
| Square or Rect. Tube | 31.4 | 40.0 | 28.6 | (35) |
| Round or Oval Pipe | 41.0 | 38.4 | 20.5 | (39) |
| Beam (I, S, W, or H) | 0.0 | 20.0 | 80.0 | (5) |
| Aluminum | | | | |
| "U" Single | 0.0 | 100.0 | 0.0 | (1) |
| Square or Rect. Tube | 0.0 | 100.0 | 0.0 | (1) |
| Round or Oval Pipe | 27.3 | 27.3 | 45.4 | (11) |
| Beam (I, S, W, or H) | 0.0 | 0.0 | 100.0 | (1) |
| Wood | | | | |
| Square or Rectangular | 36.7 | 35.0 | 28.3 | (60) |
| Round | 66.7 | 0.0 | 33.3 | (3) |
| Plastic | | | | |
| Pipe | 0.0 | 0.0 | 100.0 | (1) |

[a]Each respondent was asked to provide data on three of his most widely used single post sign systems and rank them according to extent of use.

Table C-31.

Rank in Use of the Most Widely Used Multiple Post Sign Systems, by Type of Post[a]

| Type of Material/ Cross-Sectional Shape | Rank in Use | | | Total |
|---|---|---|---|---|
| | First | Second | Third | Systems |
| | - - - Percent of Systems - - - | | | (Number) |
| Steel | | | | |
| "U" Single | 71.4 | 11.9 | 16.7 | (42) |
| "U" Back to Back | 25.0 | 75.0 | 0.0 | (4) |
| Square or Rect. Tube | 43.8 | 56.2 | 0.0 | (16) |
| Round or Oval Pipe | 61.5 | 23.1 | 15.4 | (13) |
| Beam (I, S, W, or H) | 22.2 | 40.7 | 37.1 | (27) |
| Angle (Z) | 0.0 | 100.0 | 0.0 | (1) |
| Aluminum | | | | |
| "U" Single | 50.0 | 0.0 | 50.0 | (2) |
| Square or Rect. Tube | 0.0 | 100.0 | 0.0 | (1) |
| Round or Oval Pipe | 33.3 | 44.4 | 22.3 | (9) |
| Beam (I, S, W, or H) | 50.0 | 25.0 | 25.0 | (4) |
| Wood | | | | |
| Square or Rectangular | 43.6 | 36.4 | 20.0 | (55) |
| Round | 66.7 | 33.3 | 0.0 | (3) |

[a]Each respondent was asked to provide data on three of his most widely used multiple post sign systems and rank them according to extent of use.

Table C-32.

Location of the Most Widely Used Signs, by Type Sign and Type of Post

| Type of Material/ Cross-Sectional Shape | Location by Type of Sign: Single Post Signs Urban | Single Post Signs Rural | Single Post Signs Total | Multiple Post Signs Urban | Multiple Post Signs Rural | Multiple Post Signs Total |
|---|---|---|---|---|---|---|
| | -- Percent -- | | (Number) | -- Percent -- | | (Number) |
| Steel | | | | | | |
| "U" Single | 48.5 | 51.5 | (1,483,904) | 77.8 | 22.2 | (192,654) |
| "U" Back to Back | 20.0 | 80.0 | (13,500) | 80.0 | 20.0 | (50,640) |
| Square or Rect. Tube | 57.3 | 42.7 | (818,284) | 45.8 | 54.2 | (88,529) |
| Round or Oval Pipe | 55.3 | 44.7 | (1,280,487) | 50.0 | 50.0 | (102,010) |
| Beam (I, S, W, or H) | 30.9 | 69.1 | (3,270) | 56.7 | 43.3 | (79,330) |
| Aluminum | | | | | | |
| "U" Single | 10.0 | 90.0 | (4,200) | 55.7 | 44.3 | (3,450) |
| Square or Rect. Tube | 100.0 | 0.0 | (950) | 0.0 | 100.0 | (50) |
| Round or Oval Pipe | 37.2 | 62.8 | (35,470) | 9.9 | 90.1 | (11,480) |
| Wood | | | | | | |
| Square or Rectangular | 39.6 | 60.4 | (923,075) | 71.5 | 28.5 | (147,480) |
| Round | 22.9 | 77.1 | (21,840) | 88.7 | 11.3 | (12,420) |
| Plastic | | | | | | |
| Pipe | 100.0 | 0.0 | (500) | 0.0 | 0.0 | (10) |

signs with single posts are predominately used in urban areas, then those with multiple posts are predominately used in rural areas and vice versa. No logical explanation can be given for this finding.

Sizes - The various sizes of each type of support post used by the most widely used single and multiple post sign systems are shown in Tables C-33 through C-37. The percentages are based on the total number of sign systems using a particular type of post material and cross-sectional shape. The respondents were asked to give typical sizes which are shown in the tables.

The preceding tables show some differences in the size of posts used for single post systems verus multiple post system. There are even more pronounced differences in the size of posts used by state agencies versus other agencies.

Breakaway Mechanisms - The respondents were asked to indicate the type of breakaway mechanisms, if any, used on each of their sign systems. Tables C-38 and C-39 show the extent of use of different breakaway mechanisms on each type of support post. For some of the least used systems, breakaway mechanisms are not used. Also, the findings show that breakaway mechanisms are used on less than 50 percent of the systems reported for each type of post. It is noted that there were apparent differences in the way the respondents interpreted the word "breakaway" and/or "breakaway mechanism" as given in the questionnaire (see Column 5, page A-7 and Column 6, page A-8 of Appendix A). For example, one respondent indicated that the driven U-post was breakaway. The square telescoping tube design, shown in Figure III-B-2, was reported as being breakaway

Table C-33.

Sizes of "U" Posts of the Most Widely Used Systems, by Type of Respondent, Type of Sign, and Type of Material[a]

| Type of Respondent/ Sign/Material | Size (Pounds per Foot) Under 2.00 | 2.00-2.99 | 3.00-3.99 | 4.00 or Over | Not Given | Total Systems |
|---|---|---|---|---|---|---|
| | - - - Percent of Systems - - - | | | | | (Number) |
| State Agencies | | | | | | |
| Single Post Signs | | | | | | |
| Steel "U" Single | 12.1 | 36.4 | 42.4 | 6.1 | 3.0 | (33) |
| Steel "U" Back to Back | 0.0 | 0.0 | 0.0 | 100.0 | 0.0 | (2) |
| Aluminum "U" Single [b] | 0.0 | 0.0 | 100.0 | 0.0 | 0.0 | (1) |
| Multiple Post Signs | | | | | | |
| Steel "U" Single | 4.8 | 28.6 | 47.6 | 19.0 | 0.0 | (21) |
| Steel "U" Back to Back | 0.0 | 0.0 | 0.0 | 100.0 | 0.0 | (2) |
| Aluminum "U" Single [b] | 0.0 | 0.0 | 100.0 | 0.0 | 0.0 | (1) |
| Other Government Agencies | | | | | | |
| Single Post Signs | | | | | | |
| Steel "U" Single | 0.0 | 40.7 | 20.4 | 3.7 | 35.2 | (54) |
| Steel "U" Back to Back | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | (1) |
| Multiple Post Signs | | | | | | |
| Steel "U" Single | 0.0 | 38.1 | 23.8 | 4.8 | 33.3 | (21) |
| Steel "U" Back to Back | 0.0 | 0.0 | 0.0 | 100.0 | 0.0 | (2) |
| Aluminum "U" Single [b] | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 | (1) |

[a]The respondents were asked to give a typical size for each of their sign systems.

[b]See footnote "f", Table IV-C-1, regarding sizes of aluminum U-posts.

Table C-34.

Sizes of Round Posts of the Most Widely Used Systems, by Type of Respondent, Type of Sign, and Type of Material[a]

| Type of Respondent/ Sign/Material | Size (Inches in Diameter) 2.00- 2.99 | 3.00- 3.99 | 4.00 or Over | Not Given | Total Systems |
|---|---|---|---|---|---|
| | - - - - Percent of Systems - - - - | | | | (Number) |
| State Agencies | | | | | |
| Single Post Signs | | | | | |
| Steel Pipe | 14.3 | 42.9 | 21.4 | 21.4 | (14) |
| Aluminum Pipe | 20.0 | 20.0 | 0.0 | 60.0 | (5) |
| Wood Post | 0.0 | 100.0 | 0.0 | 0.0 | (1) |
| Multiple Post Signs | | | | | |
| Steel Pipe | 16.7 | 16.7 | 16.6 | 50.0 | (6) |
| Aluminum Pipe | 0.0 | 25.0 | 50.0 | 25.0 | (4) |
| Wood Post | 0.0 | 0.0 | 100.0 | 0.0 | (2) |
| Other Agencies | | | | | |
| Single Post Signs | | | | | |
| Steel Pipe | 96.0 | 4.0 | 0.0 | 0.0 | (25) |
| Aluminum Pipe | 83.3 | 0.0 | 16.7 | 0.0 | (6) |
| Wood Post | 0.0 | 0.0 | 100.0 | 0.0 | (2) |
| Plastic Pipe | 0.0 | 0.0 | 100.0 | 0.0 | (1) |
| Multiple Post Signs | | | | | |
| Steel Pipe | 85.7 | 14.3 | 0.0 | 0.0 | (7) |
| Aluminum Pipe | 50.0 | 0.0 | 50.0 | 0.0 | (4) |
| Wood Post | 0.0 | 0.0 | 100.0 | 0.0 | (1) |

[a]The respondents were asked to give a typical size for each of their sign systems.

Table C-35.

Sizes of Square Posts of the Most Widely Used Systems, by Type of Respondent, Type of Sign, and Type of Material[a]

| Type of Respondent/ Sign/Material | Size (Inches Square) Under 2.00 | 2.00- 2.99 | 3.00- 3.99 | 4.00- 4.99 | 5.00 or Over | Not Given | Total Systems |
|---|---|---|---|---|---|---|---|
| | Percent of Systems | | | | | | (Number) |
| State Agencies | | | | | | | |
| Single Post Signs | | | | | | | |
| Steel Tube[b] | 20.0 | 46.7 | 6.7 | 0.0 | 0.0 | 26.6 | (15) |
| Wood Post | 0.0 | 0.0 | 0.0 | 77.3 | 22.7 | c | (22) |
| Multiple Post Signs | | | | | | | |
| Steel Tube[b] | 28.6 | 42.8 | 0.0 | 0.0 | 0.0 | 28.6 | (7) |
| Wood Post | 0.0 | 0.0 | 0.0 | 52.6 | 47.4 | c | (19) |
| Other Agencies | | | | | | | |
| Single Post Signs | | | | | | | |
| Steel Tube[b] | 33.3 | 55.6 | 0.0 | 0.0 | 0.0 | 11.1 | (18) |
| Wood Post | 0.0 | 0.0 | 0.0 | 87.5 | 12.5 | 0.0 | (16) |
| Multiple Post Signs | | | | | | | |
| Steel Tube[b] | 44.4 | 44.4 | 0.0 | 0.0 | 0.0 | 11.2 | (9) |
| Wood Post | 0.0 | 0.0 | 0.0 | 88.9 | 11.1 | c | (9) |

[a]The respondents were asked to give a typical size for each of their sign systems.

[b]Include perforated and nonperforated tubing.

[c]The size was not given for wood posts of seven single post systems and of 11 multiple post systems. Therefore, the shapes could not be determined.

Table C-36.

Sizes of Rectangular Posts of the Most Widely Used Systems, by Type of Respondent, Type of Sign, and Type of Material[a]

| Type of Respondent/ Sign/Material | (Inches of Rectangle) 2x3-3x4 | 4x6 | 6x8-6x10 | Not Given | Total System |
|---|---|---|---|---|---|
| | - -Percent of Systems - - | | | | (Number) |
| State Agencies | | | | | |
| Single Post Signs | | | | | |
| Steel Tube[b] | 100.0 | 0.0 | 0.0 | 0.0 | (1) |
| Wood Post | 0.0 | 100.0 | 0.0 | c | (10) |
| Multiple Post Signs | | | | | |
| Wood Post | 0.0 | 81.8 | 18.2 | c | (11) |
| Other Agenices | | | | | |
| Single Post Signs | | | | | |
| Wood Post | 0.0 | 50.0 | 50.0 | c | (2) |
| Multiple Post Signs | | | | | |
| Wood Post | 0.0 | 40.0 | 60.0 | c | (5) |

[a]The respondents were asked to give a typical size for each of their sign systems.

[b]Includes Perforated and nonperforated posts.

[c]The size was not given for wood posts of seven single post systems and of 11 multiple post systems. Therefore, the shapes could not be determined.

Table C-37.

Sizes of Beam Posts of the Most Widely Used Systems, by Type of Sign and Type of Material[a]

| Type of Sign/ Material | Size (Nominal Depth and Weight)[b] | | | | | Total |
|---|---|---|---|---|---|---|
| | Under 3x3.7 | 3x5.7- 4x7.7 | 5x10.0- 6x12.0 | 6x12.5- 8x24.0 | Not Given | Systems |
| | - - - - - - Percent of Systems | | | | - - - - - - | (Number) |
| Single Post Signs | | | | | | |
| Steel Beam (I,S,W, or H) | 20.0 | 40.0 | 20.0 | 0.0 | 20.0 | (5) |
| Aluminum Beam (I,S,W, or H) | 0.0 | 100.0 | 0.0 | 0.0 | 0.0 | (1) |
| Multiple Post Signs | | | | | | |
| Steel Beam (I,S,W, or H) | 0.0 | 40.8 | 25.9 | 11.1 | 22.2 | (2) |
| Aluminum Beam (I,S,W, or H) | 0.0 | 25.0 | 0.0 | 0.0 | 75.0 | (4) |

[a]All systems using beam posts were reported by state agencies, except one using steel angle post reported by a turnpike authority. A typical size was given for each system.

[b]The meaning of the sizes are as follows: for example, the first value (3) of the size 3x3.7 is the nominal depth in inches and the second value (3.7) is the weight in pounds per foot.

Table C-38.

Breakaway Mechanisms of the Most Widely Used Single Post Systems, by Type of Post

| Type of Post Material/ Cross-Sectional Shape | Breakaway Mechanism: Slip Base | Drilled Holes | Weakened Section | Other | Not Given | None | Total Systems |
|---|---|---|---|---|---|---|---|
| | - - - - - - - - - | Percent of Systems | - - - - - - - - | | | | (Number) |
| Steel | | | | | | | |
| "U" Single | 2.3 | 0.0 | 0.0 | 1.1 | 6.9 | 89.7 | (87) |
| "U" Back to Back | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 | (3) |
| Square or Rect. Tube | 20.0 | 2.9 | 2.9 | 17.1 | 14.3 | 42.8 | (35) |
| Round or Oval Pipe | 17.9 | 0.0 | 2.6 | 7.7 | 7.7 | 64.1 | (39) |
| Beam (I,S,W or H) | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | (5) |
| Aluminum | | | | | | | |
| "U" Single | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 | (1) |
| Square or Rect. Tube | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 | (1) |
| Round or Oval Pipe | 18.2 | 0.0 | 0.0 | 18.2 | 9.1 | 54.5 | (11) |
| Beam (I,S,W, or H) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 | (1) |
| Wood | | | | | | | |
| Square or Rectangular | 1.7 | 20.0 | 8.3 | 0.0 | 20.0 | 50.0 | (60) |
| Round | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 | (3) |

Table C-39.

Breakaway Mechanisms of the Most Widely Used Multiple Post Systems, by Type of Post

| Type of Post Material/ Cross-Sectional Shape | Breakaway Mechanism: Slip Base | Drilled Holes | Weakened Section | Other | Not Given | None | Total Systems |
|---|---|---|---|---|---|---|---|
| | - - - - - - - - Percent of Systems- | | | | | - - - - - - - - | (Number) |
| Steel | | | | | | | |
| "U" Single | 4.8 | 0.0 | 0.0 | 0.0 | 7.1 | 88.1 | (42) |
| "U" Back to Back | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 | (4) |
| Square or Rect. Tube | 0.0 | 0.0 | 6.2 | 25.0 | 12.5 | 56.3 | (16) |
| Round or Oval Pipe | 23.1 | 0.0 | 0.0 | 15.4 | 7.7 | 53.8 | (13) |
| Beam (I,S,W, or H) | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | (27) |
| Angle (Z) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 | (1) |
| Aluminum | | | | | | | |
| "U" Single | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 | (2) |
| Square or Rect. Tube | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 | (1) |
| Round or Oval Pipe | 0.0 | 0.0 | 0.0 | 22.2 | 11.1 | 66.7 | (9) |
| Beam (I,S,W, or H) | 75.0 | 0.0 | 0.0 | 0.0 | 0.0 | 25.0 | (4) |
| Wood | | | | | | | |
| Square or Rectangular | 1.8 | 25.5 | 7.3 | 0.0 | 14.5 | 50.9 | (55) |
| Round | 0.0 | 0.0 | 33.3 | 0.0 | 0.0 | 66.7 | (3) |

by many respondents and as being a "yielding" design by others. Also noteworthy is that most of the "square or rectangular tube designs" were in fact the telescoping tube design. A small percentage of rectangular tubes, without perforations, are used in combination with a slip base design (see Figure III-B-3). As shown in Tables C-38 and C-39, there is very little difference in the extent of use of various breakaway mechanisms on single post systems versus multiple post systems using the same type of support post.

Hinge Usage - The extent of hinge usage below the sign panel(s) is shown in Table C-40 for both single post and multiple post systems by type of post. The results show that little or no use is made of hinges on the various types of posts, except for the beam types. Also, there is very little difference in the usage of hinges on single post versus multiple post systems.

Design Life - The extent of use of support posts with different design lives are shown in Tables C-41 and C-42. The design life was not given for many of the types of posts. Results show that the design life of most posts of a particular type as well as among the various types varies considerably. There is not much difference in the design lives of single post versus multiple post systems using the same type of post, except for aluminum round or oval pipe posts.

Stub Post

An attempt was made to obtain data on stub posts similar to that on support posts, i.e., cross-sectional shape, typical size, type of material, typical length (total and above ground) and method and depth of embedment.

Table C-40.

Use of Hinges Below Sign Panels on the Most Widely Used Sign Systems, by Type of Post

| Type of Post Material/ Cross-Sectional Shape | Hinge Below Sign | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Single Post | | | Total Systems | Multiple Post | | | Total Systems |
| | Yes | No | Not Given | | Yes | No | Not Given | |
| | Percent of Systems | | | (Number) | Percent of Systems | | | (Number) |
| Steel | | | | | | | | |
| "U" Single | 1.1 | 94.3 | 4.6 | (87) | 2.4 | 90.5 | 7.1 | (42) |
| "U" Back to Back | 0.0 | 100.0 | 0.0 | (3) | 0.0 | 100.0 | 0.0 | (4) |
| Square or Rect. Tube | 0.0 | 94.3 | 5.7 | (35) | 0.0 | 93.8 | 6.2 | (16) |
| Round or Oval Pipe | 2.6 | 97.4 | 0.0 | (39) | 15.4 | 76.9 | 7.7 | (13) |
| Beam (I,S,W, or H) | 40.0 | 60.0 | 0.0 | (5) | 96.3 | 3.7 | 0.0 | (27) |
| Angle (Z) | 0.0 | 0.0 | 0.0 | (0) | 0.0 | 100.0 | 0.0 | (1) |
| Aluminum | | | | | | | | |
| "U" Single | 0.0 | 100.0 | 0.0 | (1) | 0.0 | 100.0 | 0.0 | (2) |
| Square or Rect. Tube | 0.0 | 100.0 | 0.0 | (1) | 0.0 | 100.0 | 0.0 | (1) |
| Round or Oval Pipe | 2.6 | 100.0 | 0.0 | (11) | 0.0 | 100.0 | 0.0 | (9) |
| Beam (I,S,W, or H) | 0.0 | 100.0 | 0.0 | (1) | 75.0 | 25.0 | 0.0 | (4) |
| Wood | | | | | | | | |
| Square or Rectangular | 6.7 | 90.0 | 3.3 | (60) | 7.3 | 89.1 | 3.6 | (55) |
| Round | 0.0 | 100.0 | 0.0 | (3) | 0.0 | 100.0 | 0.0 | (3) |
| Plastic | | | | | | | | |
| Pipe | 0.0 | 100.0 | 0.0 | (1) | 0.0 | 0.0 | 0.0 | (0) |

Table C-41.

Design Life of Support Posts of the Most Widely Used Single Post Sign Systems, by Type of Post

| Type of Post Material/ Cross-Sectional Shape | Design Life (Years) Under 10 | 10-14 | 15-19 | 20 or Over | Not Given | Total Systems |
|---|---|---|---|---|---|---|
| | - - - -Percent of Systems | | | | - - - - | (Number) |
| Steel | | | | | | |
| "U" Single | 12.6 | 23.0 | 2.3 | 10.3 | 51.8 | (87) |
| "U" Back to Back | 0.0 | 0.0 | 0.0 | 33.3 | 66.7 | (3) |
| Square or Rect. Tube | 8.6 | 22.9 | 2.9 | 14.3 | 51.3 | (35) |
| Round or Oval Pipe | 2.6 | 12.8 | 10.3 | 17.9 | 56.4 | (39) |
| Beam (I,S,W, or H) | 0.0 | 0.0 | 0.0 | 40.0 | 60.6 | (5) |
| Aluminum | | | | | | |
| "U" Single | 0.0 | 0.0 | 0.0 | 100.0 | 0.0 | (1) |
| Square of Rect. Tube | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 | (1) |
| Round or Oval Pipe | 9.1 | 18.2 | 9.1 | 18.2 | 45.4 | (11) |
| Beam (I,S,W, or H) | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 | (1) |
| Wood | | | | | | |
| Square or Rectangular | 16.7 | 15.0 | 10.0 | 13.3 | 45.0 | (60) |
| Round | 33.3 | 66.7 | 0.0 | 0.0 | 0.0 | (3) |
| Plastic | | | | | | |
| Pipe | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | (1) |

Table C-42.

Design Life of Support Posts of the Most Widely Used Multiple Post Sign Systems, by Type of Post

| Type of Post Material/ Cross-Sectional Shape | Design Life (Years) Under 10 | 10-14 | 15-19 | 20 or Over | Not Given | Total Systems |
|---|---|---|---|---|---|---|
| | - - - - - Percent of Systems | | | | - - - - - | (Number) |
| Steel | | | | | | |
| "U" Single | 9.5 | 26.2 | 2.4 | 14.3 | 47.6 | (42) |
| "U" Back to Back | 25.0 | 0.0 | 0.0 | 25.0 | 50.0 | (4) |
| Square or Rect. Tube | 6.3 | 25.0 | 0.0 | 18.7 | 50.0 | (16) |
| Round or Oval Pipe | 0.0 | 7.7 | 23.1 | 23.1 | 46.1 | (13) |
| Beam (I, S, W, or H) | 0.0 | 18.5 | 7.4 | 33.3 | 40.8 | (27) |
| Angle (Z) | 0.0 | 0.0 | 0.0 | 100.0 | 0.0 | (1) |
| Aluminum | | | | | | |
| "U" Single | 0.0 | 50.0 | 0.0 | 50.0 | 0.0 | (2) |
| Square or Rect. Tube | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 | (1) |
| Round or Oval Pipe | 22.2 | 11.1 | 22.2 | 11.1 | 33.4 | (9) |
| Beam (I, S, W, or H) | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 | (4) |
| Wood | | | | | | |
| Square or Rectangular | 18.2 | 14.5 | 7.2 | 10.9 | 49.2 | (55) |
| Round | 0.0 | 100.0 | 0.0 | 0.0 | 0.0 | (3) |

A tabulation indicates that, for a given sign system, there is very little difference in the cross-sectional shapes, typical sizes, types of materials of support posts and stub posts; therefore, no tabular data are presented on such characteristics in this report.

In the case of typical lengths of stub posts, a tabulation indicates that in many cases erroneous data were reported. For example, the respondents furnished the total length of the support post instead of that of the stub post and gave no explanation.

It was very difficult to determine whether the sign support systems reported by the respondents have stub posts. A tabulation indicated that very few of the sign systems have stub posts. Nearly all of the systems that have a stub post also have steel support posts. Not over 10 to 15 percent of the systems using a certain type of steel post have stub posts, except for those using beam posts. About 50 percent of the systems using such posts also have stub posts.

As far as method of embedment is concerned, the results presented in Tables C-43 and C-44 show that some of the most commonly used types of support posts are embedded only one way. Others are embedded three ways (driven, concrete, and back filled). The "U" posts are usually driven into the ground, pipe posts usually set in concrete, and wood posts usually set in holes (back filled). The results in Tables C-43 and C-44 show few differences in the method of embedment of posts of single post versus multiple post systems.

The depths at which support posts or stub posts are embedded are summarized in Tables C-45 and C-46 by type of support post. These

Table C-43.

Method of Support Post or Stub Post Embedment
of the Most Widely Used Single Post Sign Systems, by Type of Post

| Type of Post Material/ Cross-Sectional Shape | Method of Embedment: Driven | Concrete | Back-Filled | Not Given | Total Systems |
|---|---|---|---|---|---|
| | ---- Percent of Systems ---- | | | | (Number) |
| Steel | | | | | |
| "U" Single | 67.9 | 6.9 | 1.1 | 24.1 | (87) |
| "U" Back to Back | 66.7 | 0.0 | 0.0 | 33.3 | (3) |
| Square or Rectangular Tube | 37.2 | 31.4 | 5.7 | 25.7 | (35) |
| Round or Oval Pipe | 15.4 | 51.3 | 12.8 | 20.5 | (39) |
| Beam (I,S,W, or H) | 0.0 | 100.0 | 0.0 | 0.0 | (5) |
| Aluminum | | | | | |
| "U" Single | 100.0 | 0.0 | 0.0 | 0.0 | (1) |
| Square or Rectangular Tube | 0.0 | 100.0 | 0.0 | 0.0 | (1) |
| Round or Oval Pipe | 18.2 | 63.6 | 9.1 | 9.1 | (11) |
| Beam (I,S,W, or H) | 0.0 | 0.0 | 0.0 | 100.0 | (1) |
| Wood | | | | | |
| Square or Rectangular | 0.0 | 7.0 | 66.7 | 26.3 | (57) |
| Round | 0.0 | 0.0 | 100.0 | 0.0 | (3) |
| Plastic | | | | | |
| Pipe | 0.0 | 0.0 | 100.0 | 0.0 | (1) |

Table C-44.

Method of Support Post or Stub Post Embedment of the Most Widely Used Multiple Post Sign Systems, by Type of Post

| Type of Post Material/ Cross-Sectional Shape | Method of Embedment | | | | |
|---|---|---|---|---|---|
| | Driven | Concrete | Back-Filled | Not Given | Total Systems |
| | - - - - Percent of Systems - - - - | | | | (Number) |
| Steel | | | | | |
| "U" Single | 54.7 | 4.8 | 0.0 | 40.5 | (42) |
| "U" Back to Back | 50.0 | 25.0 | 0.0 | 25.0 | (4) |
| Square or Rectangular Tube | 25.0 | 31.2 | 6.3 | 37.5 | (16) |
| Round or Oval Pipe | 15.4 | 46.1 | 23.1 | 15.4 | (13) |
| Beam (I,S,W, or H) | 0.0 | 92.6 | 0.0 | 7.4 | (27) |
| Angle (Z) | 0.0 | 100.0 | 0.0 | 0.0 | (1) |
| Aluminum | | | | | |
| "U" Single | 50.0 | 50.0 | 0.0 | 0.0 | (2) |
| Square or Rectangular Tube | 0.0 | 100.0 | 0.0 | 0.0 | (1) |
| Round or Oval Pipe | 0.0 | 66.7 | 22.2 | 11.1 | (9) |
| Beam (I,S,W, or H) | 0.0 | 75.0 | 0.0 | 25.0 | (4) |
| Wood | | | | | |
| Square of Rectangular | 1.8 | 12.7 | 60.0 | 25.5 | (55) |
| Round | 0.0 | 0.0 | 100.0 | 0.0 | (3) |

Table C-45.

Depth of Support Post or Stub Post Embedment of the Most Widely Used Single Post Sign Systems, by Type of Post

| Type of Post Material/ Cross-Sectional Shape | Depth of Embedment (Inches)[a] | | | | | | |
|---|---|---|---|---|---|---|---|
| | Under 24 | 24-35 | 36-47 | 48-59 | 60 or Over | Not Given | Total Systems |
| | - - - - - Percent of Systems- - - - - - | | | | | | (Number) |
| Steel | | | | | | | |
| "U" Single | 4.6 | 24.1 | 24.1 | 12.7 | 3.5 | 31.0 | (87) |
| "U" Back to Back | 0.0 | 0.0 | 33.3 | 0.0 | 33.3 | 33.4 | (3) |
| Square or Rectangular Tube | 8.6 | 17.1 | 22.9 | 2.9 | 0.0 | 48.5 | (35) |
| Round or Oval Pipe | 5.1 | 30.8 | 23.1 | 5.1 | 0.0 | 35.9 | (39) |
| Beam (I,S,W, or H) | 0.0 | 60.0 | 20.0 | 0.0 | 0.0 | 20.0 | (5) |
| Aluminum | | | | | | | |
| "U" Single | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 | 0.0 | (1) |
| Square or Rectangular Tube | 0.0 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | (1) |
| Round or Oval Pipe | 0.0 | 27.3 | 18.2 | 9.1 | 9.1 | 36.3 | (11) |
| Beam (I,S,W, or H) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 | (1) |
| Wood | | | | | | | |
| Square or Rectangular | 0.0 | 11.9 | 23.7 | 10.2 | 8.5 | 45.7 | (59) |
| Round | 0.0 | 66.7 | 33.3 | 0.0 | 0.0 | 0.0 | (3) |

[a]Difference between the total and above ground lengths of the stub post. All systems having negative or zero value were placed in the "Not Given" category.

Table C-46.

Depth of Support Post or Stub Post Embedment of the Most Widely Used Multiple Post Sign Systems, by Type of Post

| Type of Post Material/ Cross-Sectional Shape | Depth of Embedment (Inches)[a] | | | | | | |
|---|---|---|---|---|---|---|---|
| | Under 24 | 24-35 | 36-47 | 48-59 | 60 or Over | Not Given | Total Systems |
| | - - - - - Percent of Systems- - - - - - | | | | | | (Number) |
| Steel | | | | | | | |
| "U" Single | 0.0 | 11.9 | 19.0 | 21.4 | 2.4 | 45.3 | (42) |
| "U" Back to Back | 0.0 | 0.0 | 50.0 | 0.0 | 25.0 | 25.0 | (4) |
| Square or Rectangular Tube | 6.3 | 18.8 | 12.5 | 0.0 | 0.0 | 62.4 | (16) |
| Round or Oval Pipe | 0.0 | 23.1 | 30.8 | 0.0 | 0.0 | 46.2 | (13) |
| Beam (I,S,W, or H) | 11.1 | 33.3 | 18.5 | 3.7 | 3.7 | 29.7 | (27) |
| Angle (Z) | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 | 0.0 | (1) |
| Aluminum | | | | | | | |
| "U" Single | 50.0 | 0.0 | 0.0 | 0.0 | 50.0 | 0.0 | (2) |
| Square or Rectangular Tube | 0.0 | 0.0 | 100.0 | 0.0 | 0.0 | 0.0 | (1) |
| Round or Oval Pipe | 22.2 | 11.1 | 33.4 | 0.0 | 1.1 | 22.2 | (9) |
| Beam (I,S,W, or H) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 | (4) |
| Wood | | | | | | | |
| Square or Rectangular | 0.0 | 9.1 | 16.3 | 5.5 | 11.0 | 58.1 | (55) |
| Round | 0.0 | 0.0 | 66.7 | 0.0 | 0.0 | 33.3 | (3) |

[a]Difference between the total and above ground lengths of the stub post. All systems having negative or zero values were placed in the "Not Given" category.

depths vary considerably by type of sign. However, most support posts or stub posts are embedded from 24 to 48 inches into the ground and/or footing. There is some variation between single post and multiple post systems. For instance, steel "U" type single posts are not embedded as deeply as steel "U" multiple posts.

Sign Panel

Information was obtained on the type of material and design life of sign panels used on the various single and multiple post sign systems.

Materials - Tables C-47 and C-48 show the extent of use of panels made of various materials by type of support post. Aluminum is shown to be used extensively. Panels made of a combination of materials, primarily plywood and aluminum, are the next most popular. The percentage of sign systems using aluminum panels varies considerably by type of support post. Also, a comparison of Tables C-47 and C-48 reveals that aluminum panels are used more frequently on single post than on multiple posts systems.

Design Life - Tables C-49 and C-50 show the extent of use of sign panels having various design lives by type of support post. Even for the same type of post, there is considerable variation.

A comparison of Tables C-49 and C-50 reveals little difference in the design life of sign panels used on single post versus multiple post systems.

Table C-47.

Sign Blank Materials of the Most Widely Used Single Post Sign Systems, by Type of Post

| Type of Post Material/ Cross-Sectional Shape | Sign Blank Material: Steel | Aluminum | Wood | Combination[a] | Not Given | Total Systems |
|---|---|---|---|---|---|---|
| | - - - - - - - | Percent of Systems | - - - - - - - | | | (Number) |
| Steel | | | | | | |
| "U" Single | 1.2 | 70.1 | 4.6 | 11.5 | 12.6 | (87) |
| "U" Back to Back | 0.0 | 66.7 | 0.0 | 0.0 | 33.3 | (3) |
| Square or Rect. Tube | 0.0 | 62.8 | 0.0 | 8.6 | 28.6 | (35) |
| Round or Oval Pipe | 7.6 | 69.2 | 2.6 | 10.3 | 10.3 | (39) |
| Beam (I, S, W, or H) | 0.0 | 80.0 | 0.0 | 20.0 | 0.0 | (5) |
| Aluminum | | | | | | |
| "U" Single | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | (1) |
| Square or Rect. Tube | 0.0 | 100.0 | 0.0 | 0.0 | 0.0 | (1) |
| Round or Oval Pipe | 9.1 | 90.9 | 0.0 | 0.0 | 0.0 | (11) |
| Beam (I, S, W, or H) | 0.0 | 0.0 | 0.0 | 100.0 | 0.0 | (1) |
| Wood | | | | | | |
| Square or Rectangular | 0.0 | 50.0 | 5.0 | 21.7 | 23.3 | (60) |
| Round | 0.0 | 33.4 | 33.3 | 33.3 | 0.0 | (3) |
| Plastic | | | | | | |
| Pipe | 0.0 | 0.0 | 0.0 | 100.0 | 0.0 | (1) |

[a]Primarily plywood and aluminum

Table C-48.

Sign Blank Materials of the Most Widely Used Multiple Post Sign Systems, by Type of Post

| Type of Post Material/ Cross-Sectional Shape | Sign Blank Material | | | | | Total |
|---|---|---|---|---|---|---|
| | Steel | Aluminum | Wood | Combination[a] | Not Given | Systems |
| | - - - - - - - - Percent of Systems - - - - - - - - | | | | | (Number) |
| Steel | | | | | | |
| "U" Single | 2.4 | 47.6 | 9.5 | 9.5 | 30.9 | (42) |
| "U" Back to Back | 0.0 | 25.0 | 25.0 | 25.0 | 25.0 | (4) |
| Square or Rect. Tube | 0.0 | 55.2 | 0.0 | 18.8 | 25.0 | (16) |
| Round or Oval Pipe | 0.0 | 69.2 | 15.4 | 7.7 | 7.7 | (13) |
| Beam (I, S, W, or H) | 0.0 | 74.1 | 7.4 | 14.8 | 3.7 | (27) |
| Angle (Z) | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 | (1) |
| Aluminum | | | | | | |
| "U" Single | 50.0 | 50.0 | 0.0 | 0.0 | 0.0 | (2) |
| Square or Rect. Tube | 0.0 | 100.0 | 0.0 | 0.0 | 0.0 | (1) |
| Round or Oval Pipe | 0.0 | 100.0 | 0.0 | 0.0 | 0.0 | (9) |
| Beam (I, S, W, or H) | 25.0 | 75.0 | 0.0 | 0.0 | 0.0 | (4) |
| Wood | | | | | | |
| Square or Rectangular | 0.0 | 34.5 | 18.2 | 29.1 | 18.2 | (55) |
| Round | 0.0 | 66.7 | 0.0 | 33.3 | 0.0 | (3) |

[a]Primarily plywood and aluminum.

Table C-49.

Design Life of Sign Panels of the Most Widely Used Single Post Sign Systems, by Type of Post

| Type of Post Material/ Cross-Sectional Shape | Design Life (Years) Under 10 | 10-14 | 15-19 | 20-29 | 30 or Over | Not Given | Total Systems |
|---|---|---|---|---|---|---|---|
| | - - - - - | Percent of | Systems | - - - - - | | | (Number) |
| Steel | | | | | | | |
| "U" Single | 46.0 | 8.1 | 3.5 | 1.1 | 1.1 | 40.2 | (87) |
| "U" Back to Back | 0.0 | 0.0 | 33.3 | 0.0 | 0.0 | 66.7 | (3) |
| Square or Rect. Tube | 25.7 | 17.1 | 5.7 | 5.7 | 2.9 | 42.9 | (35) |
| Round or Oval Pipe | 41.0 | 10.3 | 2.6 | 2.6 | 0.0 | 43.5 | (39) |
| Beam (I, S, W, or H) | 40.0 | 20.0 | 0.0 | 0.0 | 20.0 | 20.0 | (5) |
| Aluminum | | | | | | | |
| "U" Single | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | (1) |
| Square or Rect. Tube | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | (1) |
| Round or Oval Pipe | 36.4 | 9.1 | 0.0 | 0.0 | 9.1 | 45.4 | (11) |
| Beam (I, S, W, or H) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 | (1) |
| Wood | | | | | | | |
| Square or Rectangular | 35.0 | 16.7 | 6.7 | 0.0 | 3.3 | 38.3 | (60) |
| Round | 66.7 | 33.3 | 0.0 | 0.0 | 0.0 | 0.0 | (3) |
| Plastic | | | | | | | |
| Pipe | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | (1) |

Table C-50.

Design Life of Sign Panels of the Most Widely Used Multiple Post Sign Systems, by Type of Post

| Type of Post Material/ Cross-Sectional Shape | Design Life (Years) Under 10 | 10-14 | 15-19 | 20-29 | 30 or Over | Not Given | Total Systems |
|---|---|---|---|---|---|---|---|
| | ------- Percent of Systems | | | | | ------- | (Number) |
| Steel | | | | | | | |
| "U" Single | 52.4 | 2.4 | 4.8 | 0.0 | 2.4 | 38.1 | (42) |
| "U" Back to Back | 25.0 | 0.0 | 25.0 | 0.0 | 0.0 | 50.0 | (4) |
| Square or Rect. Tube | 25.0 | 18.8 | 6.3 | 12.5 | 0.0 | 37.4 | (16) |
| Round or Oval Pipe | 61.5 | 0.0 | 0.0 | 7.7 | 7.7 | 23.1 | (13) |
| Beam (I, S, W, or H) | 33.4 | 29.6 | 3.7 | 0.0 | 7.4 | 25.9 | (27) |
| Angle (Z) | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | (1) |
| Aluminum | | | | | | | |
| "U" Single | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | (2) |
| Square or Rect. Tube | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | (1) |
| Round or Oval Pipe | 55.6 | 0.0 | 0.0 | 0.0 | 11.1 | 33.3 | (9) |
| Beam (I, S, W, or H) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 | (4) |
| Wood | | | | | | | |
| Square or Rectangular | 32.7 | 23.6 | 0.0 | 0.0 | 1.8 | 41.9 | (55) |
| Round | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | (3) |

## Installation Costs

In order to determine the magnitude of the initial investment required for the most widely used sign support systems, the respondents were asked to furnish installation costs. They were first asked to furnish complete sign system data including the total cost of each sign installation, the total labor required, and the percentage of total installation cost due to labor. Secondly, they were asked to allocate the total system cost and labor (man-hours) required among each component of the sign system, i.e., footing, and/or stub post, support post, and sign panel.

The total cost of a sign system, as defined to the respondents, includes the cost of materials, site preparation and labor. It excludes overhead and transportation charges. The installation costs are based on the respondents' cost estimates on a per-sign basis assuming 100 sign installations.

### Complete System Data

The respondents furnished installation cost and labor requirement data on the majority of their most widely used sign systems. However, no cost data were reported for some of less frequently used systems.

The cost and labor requirement data (values in each array) are summarized in the tables by using the median as the measure of central tendency. To give the reader an idea of the extent of the variation of the majority of the values about the median and ignoring the most extreme values which could be errors in reporting, the 25th and 75th percentile (quartile) values are shown in the tables. Percentile and median values are interpreted as follows: 25 percent of the respondents reported costs equal to or less than the 25th percentile value and 75 percent of the respondents reported costs equal to or less than the 75th percentile value. Also, 50 percent of the respondents reported costs equal to or less than the median value. The percentile and median values are based on arrays which exclude all sign systems having zero or missing values. Therefore, the number of systems shown in the tables represents those systems in which the respondents reported cost data.

Total Installation Cost. Tables C-51 and C-52 show the total installation cost of single and multiple post sign systems, respectively. As might be expected, the multiple post systems cost more than single post systems. Also, there is considerably more variation in the cost of multiple post systems that use different types of support posts. Systems using steel square or rectangular tube type posts show the lowest total installation cost for both single and multiple post systems. Those with beam or angle type posts are the most expensive.

Several points need to be discussed with regard to these cost data. First, there is the question of what is a "typical" small single post sign installation and a "typical" small multiple post sign installation. Unfortunately, there is no unique answer. However, based on the responses, a typical small single post sign installation has a panel area between 5 $ft^2$ (0.47 $m^2$) and about 15 $ft^2$ (1.40 $m^2$) and the sign is mounted from 5 ft (1.53 m) to 7 ft (2.14 m) above the ground. A typical small multiple post sign installation has a panel area

Table C-51.

Total Installation Cost of the Most Widely Used Single Post Sign Systems, by Type of Post

| Type of Post Material/ Cross-Sectional Shape | Total Installation Cost | | | Total Systems |
|---|---|---|---|---|
| | Percentile Value | | Median Value | |
| | 25th | 75th | | |
| | $/Sign | | | (Number) |
| Steel | | | | |
| "U" Single | 23 | 39 | 35 | (65) |
| Square or Rectangular Tube | 29 | 85 | 34 | (22) |
| Round or Oval Pipe | 32 | 85 | 42 | (33) |
| Beam (I,S,W, or H) | 150 | 614 | 312 | (3) |
| Aluminum | | | | |
| Square or Rectangular Tube | a | a | 29 | (1) |
| Round or Oval Pipe | 19 | 94 | 40 | (5) |
| Wood | | | | |
| Square or Rectangular | 30 | 99 | 42 | (38) |
| Round | 39 | 76 | 49 | (3) |

[a]Insufficient data.

Table C-52.

Total Installation Cost of the Most Widely Used Multiple Post Sign Systems, by Type of Post

| Type of Post Material/ Cross-Sectional Shape | Total Installation Cost: Percentile Value 25th | Percentile Value 75th | Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - - $/Sign- | | - - - - - | (Number) |
| Steel | | | | |
| "U" Single | 60 | 141 | 82 | (25) |
| "U" Back to Back | a | a | 139 | (1) |
| Square or Rectangular Tube | 48 | 205 | 74 | (11) |
| Round or Oval Pipe | 9 | 138 | 62 | (7) |
| Beam (I,S,W, or H) | 289 | 1106 | 660 | (17) |
| Angle (Z) | a | a | 1018 | (1) |
| Aluminum | | | | |
| "U" Single | a | a | 113 | (1) |
| Square or Rectangular Tube | a | a | 119 | (1) |
| Round or Oval Pipe | 80 | 211 | 180 | (5) |
| Wood | | | | |
| Square or Rectangular | 116 | 322 | 217 | (32) |
| Round | 168 | 478 | 350 | (3) |

[a]Insufficient data.

between 15 $ft^2$ (1.40 $m^2$) and about 35 $ft^2$ (3.26 $m^2$) and the sign is mounted from 5 ft (1.53 m) to 7 ft (2.14 m) above the ground. Typically the sign blank is aluminum, although other materials are used. While the number of supports in a multiple post sign installation can range from two to four or five, it is conjectured that two to three supports are "typical". Hence, while the costs are representative of "typical" installations, variations are to be expected from agency to agency. Secondly, these costs are primarily for new roadway installations or major reconstruction projects. Much of the data was probably taken from bid costs especially for the state agencies, and therefore represent contract costs. Thirdly, there appears to be contradictions in some of the data. For example, the total cost of a typical single steel square or rectuangular tube post installation is slightly less than that of a steel "U" post installation (see Table III-C-3). However, when comparing the unit cost of the support material (see Tables III-C-4, III-C-6, and III-C-7) and the manpower required to install each system (see Table C-62) one would conclude that the cost of the "U"-post installation would be somewhat less than the tubular installation.

Breaking down the installation costs by type of respondent, as shown in Tables C-53 and C-54, reveals that state agencies pay more than other agencies to install systems with the same type of support post. However, as a general rule the average support for small signs on state highways will be larger in size than the same type of support in the cities.

Table C-53.

Total Installation Cost of Selected Single Post Sign Systems, by Type of Post and Type of Respondent

| Type of Respondent/ Type of Post | Total Installation Cost | | | |
|---|---|---|---|---|
| | Percentile Value | | Median | Total |
| | 25th | 75th | Value | Systems |
| | - - - - -$/Sign - - - - - | | | (Number) |
| State Agencies | | | | |
| Steel | | | | |
| "U" Single | 26 | 81 | 38 | (21) |
| Square or Rectangular Tube | 44 | 170 | 92 | (10) |
| Round or Oval Pipe | 74 | 380 | 159 | (12) |
| Wood | | | | |
| Square or Rectangular | 26 | 131 | 43 | (25) |
| Other Agencies | | | | |
| Steel | | | | |
| "U" Single | 23 | 38 | 30 | (44) |
| Square or Rectangular Tube | 29 | 47 | 38 | (12) |
| Round or Oval Pipe | 31 | 45 | 36 | (21) |
| Wood | | | | |
| Square or Rectangular | 38 | 49 | 40 | (13) |

Table C-54.

Total Installation Cost of Selected Multiple Post Sign Systems, by Type of Post and Type of Respondent

| Type of Respondent/ Type of Post | Total Installation Cost: Percentile Value 25th | Total Installation Cost: Percentile Value 75th | Total Installation Cost: Median Value | Total Systems |
|---|---|---|---|---|
| | ------ $/Sign- | | ------ | (Number) |
| State Agencies | | | | |
| Steel | | | | |
| "U" Single | 66 | 150 | 101 | (14) |
| Square or Rectangular Tube | 83 | 540 | 204 | (6) |
| Wood | | | | |
| Square or Rectangular | 160 | 440 | 235 | (22) |
| Other Agencies | | | | |
| Steel | | | | |
| "U" Single | 50 | 105 | 64 | (11) |
| Square or Rectangular Tube | 39 | 71 | 58 | (5) |
| Wood | | | | |
| Square or Rectangular | 116 | 250 | 122 | (10) |

The extent of regional variations in installation cost of single post sign systems using steel "U" single posts is shown in Table C-55. Efforts to determine regional variations in installation costs of the other widely used posts were unsuccessful due to limited data.

A breakdown of the installation costs of single post systems according to type of base design (Table C-56) shows that those with breakaway features cost more to install. Also, cross-tabulating the installation costs of single post systems by method of embedment (Table C-57) shows those systems embedded in concrete usually are the most expensive.

Percentage of Cost Due to Labor. Tables C-58 and C-59 show the percentages of total installation costs for labor of single and multiple post sign systems with different types of support posts. Except for sign systems with aluminum posts, the percentages of total installation costs for labor are higher for multiple posts than for single post signs.

Tables C-58 and C-59 also show that systems with steel round or oval pipe and wood support posts have the highest labor cost percentages for both single and multiple post signs.

A cross-tabulation by type of respondent reveals that state agencies pay out a higher percentage of the total installation cost for labor, especially for multiple post systems, than do other agencies (Tables C-60 and C-61).

Total Labor Used. The total man-hours of labor used to prepare the site and install the most widely used single and multiple sign

Table C-55.

Total Installation Cost of Single Post Sign Systems Using Steel "U" Single Type of Posts, by Region

| Region | Total Installation Cost: Percentile Value 25th | Total Installation Cost: Percentile Value 75th | Total Installation Cost: Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - - - - $/Sign | - - - - - - | | (Number) |
| 1&2 | 23 | 36 | 29 | (14) |
| 3 | 12 | 85 | 35 | (10) |
| 4 | 30 | 53 | 42 | (7) |
| 5 | 31 | 40 | 38 | (14) |
| 6 | 19 | 38 | 24 | (6) |
| 7 | 23 | 33 | 26 | (7) |
| 8 | 29 | 36 | 35 | (5) |
| 9 | a | a | 40 | (1) |
| 10 | a | a | 35 | (1) |
| All | 23 | 39 | 35 | (65) |

[a]Insufficient data.

Table C-56.

Total Installation Cost of Selected Single Post Sign Systems, by Type of Base Design

| Type of Post/ Base Design | Total Installation Cost: Percentile Value 25th | Percentile Value 75th | Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - - - -$/Sign- | - - - - - - - | | (Number) |
| Steel "U" Single Posts | | | | |
| Fixed | 22 | 36 | 29 | (24) |
| Yielding or Base Bending | 25 | 42 | 36 | (38) |
| Breakaway | a | a | 5 | (1) |
| Steel Tube Posts | | | | |
| Fixed | a | a | 36 | (4) |
| Yielding or Base Bending | 28 | 160 | 48 | (8) |
| Breakaway | 32 | 88 | 50 | (9) |
| Steel Pipe Posts | | | | |
| Fixed | 32 | 48 | 40 | (16) |
| Yielding or Base Bending | 27 | 62 | 39 | (7) |
| Breakaway | 51 | 380 | 159 | (8) |
| Wood Posts | | | | |
| Fixed | 31 | 52 | 40 | (12) |
| Yielding or Base Bending | 29 | 74 | 40 | (9) |
| Breakaway | 37 | 135 | 88 | (14) |

[a] Insufficient data.

Table C-57.

Total Installation Cost of Selected Single Post Sign Systems, by Method of Embedment

| Type of Post/ Method of Embedment | Total Installation Cost: Percentile Value 25th | Total Installation Cost: Percentile Value 75th | Total Installation Cost: Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - - $/Sign- | | - - - - - - | (Number) |
| Steel "U" Single Posts | | | | |
| Driven | 23 | 38 | 33 | (44) |
| Concrete | 12 | 37 | 20 | (6) |
| Backfilled | a | a | 35 | (1) |
| Steel Tube Posts | | | | |
| Driven | 29 | 80 | 39 | (10) |
| Concrete | 28 | 170 | 48 | (6) |
| Backfilled | a | a | a | (0) |
| Steel Pipe Posts | | | | |
| Driven | 22 | 86 | 32 | (5) |
| Concrete | 31 | 77 | 44 | (18) |
| Backfilled | a | a | 41 | (4) |
| Wood Posts | | | | |
| Driven | a | a | 49 | (1) |
| Concrete | a | a | 102 | (4) |
| Backfilled | 26 | 59 | 38 | (25) |

[a]Insufficient data.

Table C-58.

Percentage of Total Cost for Labor to Install the Most Widely Used Single Post Sign Systems, by Type of Post

| Type of Post Material/ Cross-Sectional Shape | Percentage of Total Cost: Percentile Value 25th | Percentage of Total Cost: Percentile Value 75th | Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - - Percent | | - - - - - | (Number) |
| Steel | | | | |
| "U" Single | 18 | 39 | 25 | (63) |
| Square or Rectangular Tube | 10 | 45 | 25 | (20) |
| Round or Oval Pipe | 20 | 50 | 30 | (29) |
| Beam (I,S,W, or H) | 14 | 25 | 20 | (2) |
| Aluminum | | | | |
| Square or Rectangular Tube | a | a | 25 | (1) |
| Round or Oval Pipe | 14 | 55 | 20 | (5) |
| Wood | | | | |
| Square or Rectangular | 20 | 43 | 29 | (32) |
| Round | 31 | 39 | 35 | (3) |

[a] Insufficient data.

Table C-59.

Percentage of Total Cost for Labor to Install the Most Widely Used Multiple Post Systems, by Type of Sign

| Type of Post Material/ Cross-Sectional Shape | Percentage of Total Cost: Percentile Value 25th | Percentage of Total Cost: Percentile Value 75th | Percentage of Total Cost: Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - - Percent | | - - - - - | (Number) |
| Steel | | | | |
| "U" Single | 14 | 39 | 25 | (25) |
| "U" Back to Back | a | a | 20 | (1) |
| Square or Rectangular Tube | 8 | 50 | 15 | (9) |
| Round or Oval Pipe | 15 | 37 | 33 | (5) |
| Beam (I,S,W, or H) | 14 | 45 | 28 | (14) |
| Angle (Z) | a | a | 9 | (1) |
| Aluminum | | | | |
| "U" Single | a | a | 12 | (1) |
| Square or Rectangular Tube | a | a | 13 | (1) |
| Round or Oval Pipe | 7 | 20 | 15 | (5) |
| Wood | | | | |
| Square or Rectangular | 24 | 50 | 40 | (26) |
| Round | 28 | 35 | 35 | (3) |

[a] Insufficient data.

Table C-60.

Percentage of Total Cost for Labor to Install Selected Single Post Sign Systems, by Type of Post and Type of Respondent

| Type of Respondent/ Type of Post | Percentage of Total Cost: Percentile Value 25th | Percentage of Total Cost: Percentile Value 75th | Percentage of Total Cost: Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - - - Percent | | - - - - - - | (Number) |
| Stage Agencies | | | | |
| Steel | | | | |
| "U" Single | 20 | 48 | 24 | (19) |
| Square or Rectangular Tube | 21 | 60 | 50 | (8) |
| Round or Oval Pipe | 35 | 58 | 50 | (10) |
| Aluminum | | | | |
| Round or Oval Pipe | 16 | 58 | 20 | (3) |
| Wood | | | | |
| Square or Rectangular | 20 | 50 | 32 | (19) |
| Other Agencies | | | | |
| Steel | | | | |
| "U" Single | 18 | 36 | 25 | (44) |
| Square or Rectangular Tube | 10 | 28 | 18 | (12) |
| Round or Oval Pipe | 20 | 38 | 24 | (19) |
| Aluminum | | | | |
| Round or Oval Pipe | 10 | 50 | 30 | (2) |
| Wood | | | | |
| Square or Rectangular | 19 | 38 | 26 | (13) |

Table C-61.

Percentage of Total Cost for Labor to Install Selected Multiple Post Sign Systems, by Type of Post and Type of Respondent

| Type of Respondent/ Type of Post | Percentage of Total Cost: Percentile Value 25th | Percentage of Total Cost: Percentile Value 75th | Percentage of Total Cost: Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - - - Percent | | - - - - - - | (Number) |
| State Agencies | | | | |
| Steel | | | | |
| "U" Single | 20 | 40 | 29 | (14) |
| Square or Rectangular Tube | 29 | 55 | 50 | (4) |
| Round or Oval Pipe | a | a | 33 | (3) |
| I-Beam | 14 | 45 | 28 | (14) |
| Aluminum | | | | |
| Round or Oval Pipe | 16 | 20 | 20 | (3) |
| Wood | | | | |
| Square or Rectangular | 18 | 60 | 43 | (16) |
| Other Agencies | | | | |
| Steel | | | | |
| "U" Single | 11 | 27 | 19 | (11) |
| Square or Rectangular Tube | 7 | 20 | 14 | (5) |
| Round or Oval Pipe | 12 | 16 | 14 | (2) |
| Aluminum | | | | |
| Round or Oval Pipe | 5 | 7 | 6 | (2) |
| Wood | | | | |
| Square or Rectangular | 25 | 43 | 40 | (10) |

[a] Insufficient data

systems are presented in Tables C-62 and C-63 by type of support post. As can be seen, multiple post systems usually require more labor than do single post signs. In some cases, the amount of labor required to install multiple post signs is double that required for single post signs.

Sign systems with steel round or oval pipe posts require the least labor, and those with steel beam posts require the most labor (Tables C-62 and C-63).

On a type of respondent basis, Tables C-64 and C-65 show that state agencies usually expend more labor to install a sign system with the same type of support post than do other agencies. On a regional basis, Table C-66 shows that the total labor expended to install single post systems with steel "U" single posts is about the same for six of 10 regions.

Unit Labor Cost - Using the total labor installation cost and the total man-hours of labor required for sign installation, the unit labor costs for installing the most widely used sign systems were calculated by type of respondent and by region. As is shown in Table C-67, the unit labor cost for sign installation is higher for state agencies than for other agencies. The variation in unit labor costs among regions is even more pronounced. Region 7 shows the lowest unit labor cost while Region 10 shows the highest. The extremely high unit labor cost shown for Region 10 can be partially explained as this region includes Alaska where labor and material costs are very high.

Table C-62.

Total Labor Used for Installation of the Most Widely Used Single Post Sign Systems, by Type of Post

| Type of Post Material/ Cross-Sectional Shape | Total Labor: Percentile Value 25th | Total Labor: Percentile Value 75th | Total Labor: Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - Man-Hours/Sign | - - - - | | (Number) |
| Steel | | | | |
| "U" Single | 0.5 | 2.0 | 1.0 | (62) |
| Square or Rectangular Tube | 0.6 | 3.0 | 1.5 | (20) |
| Round or Oval Pipe | 0.8 | 2.0 | 1.0 | (30) |
| Beam (I, S, W, or H) | 0.6 | 1.6 | 11.0 | (2) |
| Aluminum | | | | |
| Square or Rectangular Tube | a | a | 0.8 | (1) |
| Round or Oval Pipe | 0.9 | 4.0 | 2.0 | (5) |
| Wood | | | | |
| Square or Rectangular | 1.0 | 2.0 | 2.0 | (32) |
| Round | 2.0 | 2.0 | 2.0 | (3) |

[a] Insufficient data

Table C-63.

Total Labor Used for Installation of the Most Widely Used Multiple Post Systems, by Type of Post

| Type of Post Material/ Cross-Sectional Shape | Total Labor: Percentile Value 25th | Total Labor: Percentile Value 75th | Total Labor: Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - Man-Hours/Sign - - - - | | | (Number) |
| Steel | | | | |
| "U" Single | 1.0 | 2.5 | 1.8 | (26) |
| "U" Back to Back | a | a | 4.0 | (1) |
| Square or Rectangular Tube | 1.0 | 2.5 | 1.3 | (10) |
| Round or Oval Pipe | 0.3 | 3.0 | 1.0 | (5) |
| Beam (I, S, W, or H) | 6.7 | 15.3 | 10.5 | (13) |
| Angle (Z) | a | a | 12.0 | (1) |
| Aluminum | | | | |
| "U" Single | a | a | 2.0 | (1) |
| Square or Rectangular Tube | a | a | 1.5 | (1) |
| Round or Oval Pipe | 2.0 | 6.5 | 2.0 | (5) |
| Wood | | | | |
| Square or Rectangular | 3.0 | 7.3 | 4.0 | (26) |
| Round | 3.0 | 3.8 | 3.0 | (3) |

[a] Insufficient data

Table C-64.

Total Labor Used for Installation of Selected Single Post Sign Systems, by Type of Post and Type of Respondent

| Type of Respondent/ Type of Post | Total Labor: Percentile Value 25th | Total Labor: Percentile Value 75th | Total Labor: Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - Man-Hours/Sign | - - - - | | (Number) |
| Stage Agencies | | | | |
| Steel | | | | |
| "U" Single | 0.7 | 2.0 | 1.0 | (19) |
| Square or Rectangular Tube | 1.1 | 4.3 | 2.5 | (8) |
| Round or Oval Pipe | 2.0 | 6.0 | 4.0 | (9) |
| Wood | | | | |
| Square or Rectangular | 1.3 | 2.0 | 2.0 | (19) |
| Other Agencies | | | | |
| Steel | | | | |
| "U" Single | 0.5 | 1.4 | 1.0 | (43) |
| Square or Rectangular Tube | 0.5 | 1.8 | 1.0 | (12) |
| Round or Oval Pipe | 0.7 | 1.7 | 1.0 | (21) |
| Wood | | | | |
| Square or Rectangular | 0.9 | 2.1 | 1.3 | (13) |

Table C-65.

Total Labor Used for Installation of Selected Multiple Post Sign Systems, by Type of Post and Type of Respondent

| Type of Respondent/ Type of Post | Total Labor: Percentile Value 25th | Total Labor: Percentile Value 75th | Total Labor: Median Value | Total Systems |
|---|---|---|---|---|
| | - - - -Man-Hrs/Sign- - - - | | | (Number) |
| State Agencies | | | | |
| Steel | | | | |
| "U" Single | 1.0 | 2.5 | 2.0 | (14) |
| Square or Rectangular Tube | 1.7 | 6.0 | 3.3 | (4) |
| Round or Oval Pipe | 0.3 | 5.7 | 0.3 | (3) |
| Wood | | | | |
| Square or Rectangular | 3.0 | 5.0 | 3.0 | (16) |
| Other Agencies | | | | |
| Steel | | | | |
| "U" Single | 1.0 | 2.5 | 1.5 | (12) |
| Square or Rectangular Tube | 0.6 | 1.5 | 1.0 | (6) |
| Round or Oval Pipe | 1.0 | 1.5 | 1.3 | (2) |
| Wood | | | | |
| Square or Rectangular | 4.0 | 9.0 | 5.1 | (10) |

Table C-66.

Total Labor Used for Installation of Single Post Systems with Steel "U" Single Posts, by Region

| Region | Total Labor: Percentile Value 25th | Total Labor: Percentile Value 75th | Total Labor: Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - Man-Hrs/Sign | - - - - | | (Number) |
| 1 & 2 | 1.0 | 2.0 | 1.0 | (13) |
| 3 | 0.5 | 1.0 | 0.6 | (10) |
| 4 | 0.6 | 1.9 | 0.8 | (7) |
| 5 | 0.7 | 2.0 | 1.0 | (13) |
| 6 | 1.0 | 1.5 | 1.0 | (6) |
| 7 | 0.8 | 2.0 | 1.0 | (7) |
| 8 | a | 5.5 | 1.0 | (4) |
| 9 | a | a | 2.5 | (1) |
| 10 | a | a | 1.0 | (1) |

[a] Insufficient data.

Table C-67.

Unit Labor Cost of Installation of the Most Widely Used Sign Systems, by Type of Respondent and Region[a]

| Type of Respondent/ Region | Unit Labor Cost[b] | | | Total Systems |
|---|---|---|---|---|
| | Percentile Value | | Median Value | |
| | 25th | 75th | | |
| | - - - - - $/Man-Hour - - - - - | | | (Number) |
| Type of Respondent | | | | |
| State Agencies | 6.00 | 25.38 | 10.53 | (118) |
| Other | 5.93 | 10.00 | 7.21 | (131) |
| All | 5.99 | 14.52 | 7.98 | (249) |
| Region | | | | |
| 1&2 | 3.18 | 11.65 | 5.59 | (32) |
| 3 | 6.34 | 16.67 | 7.72 | (34) |
| 4 | 6.67 | 10.54 | 8.59 | (25) |
| 5 | 6.09 | 13.17 | 10.00 | (33) |
| 6 | 3.77 | 9.84 | 7.94 | (36) |
| 7 | 4.11 | 7.00 | 5.93 | (25) |
| 8 | 5.80 | 15.10 | 7.02 | (25) |
| 9 | 7.19 | 15.89 | 9.39 | (11) |
| 10 | 10.22 | 77.71 | 34.75 | (28) |

[a]Includes both single and multiple post systems.

[b]Based on total labor installation cost and total labor for sign installation.

Component System Data

As was indicated earlier, the respondents were asked to indicate the percentage of total installation cost and the percentage of total labor required that were attributable to the installation of the separate components of each sign support system. The respondents attempted to furnish such information on a majority of their most widely used sign systems. However, a considerable number of respondents misunderstood the instructions and subtracted the percentage of total installation cost attributable to labor from 100 percent and allocated the remainder among the component parts of the sign system. This resulted in some of the respondents' percentages summing to less than 100 percent. There were others whose percentages added up to over 100 percent, even ignoring the percentage of labor cost. It was first decided to use only data developed from respondents who apparently understood the instructions. But a further check revealed that those percentages adding to less than 100 percent more or less canceled out those adding to more than 100 percent. The results indicate that median values developed from data supplied by all the respondents are not too different from median values developed from data supplied by respondents who understood the instructions. Therefore, the decision was made to build the tables from data furnished by all the respondents.

Percentage of Sign Installation Cost. Tables C-68 through C-73 give percentages of total sign installation costs attributable to the component parts of single and multiple post sign systems by type of support post. Even though the median percentages of all the components of sign systems that use a particular type of post do not add to 100,

Table C-68.

Percentage of Total Sign Cost for Footing and/or Stub Post Installation of the Most Widely Used Single Post Sign Systems, by Type of Post

| Type of Post Material/ Cross-Sectional Shape | Percentage of Total Cost: Percentile Value 25th | Percentage of Total Cost: Percentile Value 75th | Percentage of Total Cost: Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - -Percent- | - - - - | | (Number) |
| Steel | | | | |
| "U" Single | 5 | 23 | 16 | (14) |
| Square or Rectangular Tube | 5 | 14 | 9 | (11) |
| Round or Oval Pipe | 10 | 28 | 21 | (22) |
| Beam (I, S, W, or H) | 9 | 41 | 36 | (3) |
| Angle (Z) | | | | |
| Aluminum | | | | |
| Square or Rectangular Tube | a | a | 8 | (1) |
| Round or Oval Pipe | 5 | 25 | 8 | (4) |
| Wood | | | | |
| Square or Rectangular | 12 | 27 | 17 | (8) |
| Round | a | a | 26 | (1) |

[a]Insufficient data

Table C-69.

Percentage of Total Sign Cost for Footing and/or Stub Post Installation of the Most Widely Used Multiple Post Sign Systems, by Type of Post

| Type of Post Material/ Cross-Sectional Shape | Percentage of Total Cost: Percentile Value 25th | Percentage of Total Cost: Percentile Value 75th | Percentage of Total Cost: Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - -Percent- | | - - - - | (Number) |
| Steel | | | | |
| "U" Single | 14 | 21 | 19 | (4) |
| Square or Rectangular Tube | 5 | 15 | 10 | (6) |
| Round or Oval Pipe | 8 | 19 | 13 | (2) |
| Beam (I, S, W, or H) | 14 | 25 | 20 | (17) |
| Angle (Z) | a | a | 3 | (1) |
| Aluminum | | | | |
| "U" Single | 4 | 4 | 4 | (1) |
| Square or Rectangular Tube | a | a | 7 | (1) |
| Round or Oval Pipe | 3 | 40 | 10 | (5) |
| Wood | | | | |
| Square or Rectangular | 10 | 25 | 10 | (8) |
| Round | 9 | 11 | 10 | (2) |

[a]Insufficient data

Table C-70

Percentage of Total Sign Cost for Support Post Installation of the Most Widely Used Single Post Sign Systems, by Type of Post

| Type of Post Material/ Cross-Sectional Shape | Percentage of Total Cost | | | |
|---|---|---|---|---|
| | Percentile Value | | Median Value | Total Systems |
| | 25th | 75th | | |
| | - - - - -Percent- - - - - | | | (Number) |
| Steel | | | | |
| "U" Single | 22 | 35 | 29 | (56) |
| Square or Rectangular Tube | 20 | 47 | 34 | (20) |
| Round or Oval Pipe | 24 | 35 | 28 | (26) |
| Beam (I, S, W, or H) | 34 | 51 | 40 | (3) |
| Aluminum | | | | |
| Square or Rectangular Tube | a | a | 27 | (1) |
| Round or Oval Pipe | 18 | 50 | 40 | (4) |
| Wood | | | | |
| Square or Rectangular | 17 | 26 | 21 | (31) |
| Round | 22 | 27 | 25 | (2) |

[a]Insufficient data

Table C-71.

Percentage of Total Sign Cost for Support Post Installation of the Most Widely Used Multiple Post Systems, by Type of Post

| Type of Post Material/ Cross-Sectional Shape | Percentage of Total Cost: Percentile Value 25th | Percentage of Total Cost: Percentile Value 75th | Percentage of Total Cost: Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - -Percent- | | - - - - | (Number) |
| Steel | | | | |
| "U" Single | 15 | 30 | 23 | (21) |
| Square or Rectangular Tube | 20 | 35 | 29 | (10) |
| Round or Oval Pipe | 24 | 52 | 33 | (4) |
| Beam (I, S, W, or H) | 29 | 43 | 38 | (17) |
| Angle (Z) | a | a | 39 | (1) |
| Aluminum | | | | |
| "U" Single | a | a | 22 | (1) |
| Square or Rectangular Tube | a | a | 13 | (1) |
| Round or Oval Pipe | 34 | 45 | 38 | (5) |
| Wood | | | | |
| Square or Rectangular | 15 | 30 | 20 | (25) |
| Round | 9 | 11 | 10 | (2) |

[a]Insufficient data

Table C-72.

Percentage of Total Sign Cost for Panel Installation of the Most Widely Used Single Post Sign Systems, by Type of Post

| Type of Post Material/ Cross-Sectional Shape | Percentage of Total Cost: Percentile Value 25th | 75th | Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - -Percent- | | - - - - | (Number) |
| Steel | | | | |
| "U" Single | 30 | 54 | 43 | (61) |
| Square or Rectangular Tube | 30 | 54 | 41 | (21) |
| Round or Oval Pipe | 28 | 49 | 37 | (28) |
| Beam (I, S, W, or H) | 14 | 28 | 26 | (3) |
| Aluminum | | | | |
| Square or Rectangular Tube | a | a | 48 | (1) |
| Round or Oval Pipe | 25 | 43 | 35 | (4) |
| Wood | | | | |
| Square or Rectangular | 40 | 70 | 56 | (36) |
| Round | 27 | 58 | 47 | (3) |

[a] Insufficient data

Table C-73.

Percentage of Total Sign Cost for Panel Installation of the Most Widely Used Multiple Post Sign Systems, by Type of Sign

| Type of Post Material/ Cross-Sectional Shape | Percentage of Total Cost: Percentile Value 25th | 75th | Median Value | Total Systems |
|---|---|---|---|---|
| | ------ Percent | ------ | ------ | (Number) |
| Steel | | | | |
| "U" Single | 40 | 62 | 56 | (24) |
| Square or Rectangular Tube | 25 | 59 | 41 | (11) |
| Round or Oval Pipe | | | 52 | (5) |
| Beam (I, S, W, or H) | 25 | 42 | 33 | (17) |
| Angle (Z) | a | a | 49 | (1) |
| Aluminum | | | | |
| "U" Single | a | a | 58 | (1) |
| Square or Rectangular Tube | a | a | 86 | (1) |
| Round or Oval Pipe | 40 | 57 | 50 | (5) |
| Wood | | | | |
| Square or Rectangular | 45 | 70 | 55 | (30) |
| Round | 44 | 61 | 47 | (3) |

[a]Insufficient data

they represent gross estimates that may be useful, especially in comparing the relative costs of a particular component for sign systems using different support posts.

Tables C-68 and C-69 show the percentages of total installation costs that are attributable to footings and/or stub posts. Footings of systems using beam type posts require a higher percentage of total installation cost than do those using other types of post.

Tables C-70 and C-71 show the percentages of total installation costs attributable to support posts of single and multiple post systems. These percentages include the cost of windbeams when used. Support posts made of wood require the lowest percentage of total installation cost.

Tables C-72 and C-73 show the percentages of total installation costs attributable to sign panels of single and multiple post systems. These percentages include the cost of the sign blank and sign surface (reflectorization, legend, etc.). Systems using beam types of posts show the lowest percentages of total installation costs due to the panel.

Percentage of Total Labor. Tables C-74 through C-79 give the percentages of total labor required for installation of the component parts of single and multiple post sign systems by type of support post. As a general rule, these percentages are more reliable than the installation cost percentages.

Tables C-74 and C-75 show the percentages of total labor for footing and/or stub post installation. For most systems, the labor required to install the footing and/or stub post represents at least 50 percent of

Table C-74.

Percentage of Total Labor for Footing and/or Stub Post Installation of the Most Widely Used Single Post Sign Systems, by Type of Sign

| Type of Post Material/ Cross-Sectional Shape | Percentage of Total Labor | | | Total Systems |
|---|---|---|---|---|
| | Percentile Value | | Median Value | |
| | 25th | 75th | | |
| | - - - - -Percent- - - - - - | | | (Number) |
| Steel | | | | |
| "U" Single | 15 | 50 | 50 | (14) |
| Square or Rectangular Tube | 33 | 50 | 45 | (10) |
| Round or Oval Pipe | 50 | 75 | 50 | (20) |
| Beam (I, S, W, or H) | 50 | 85 | 68 | (2) |
| Aluminum | | | | |
| Square or Rectangular Tube | a | a | 90 | (1) |
| Round or Oval Pipe | 3 | 58 | 7 | (3) |
| Wood | | | | |
| Square or Rectangular | 45 | 73 | 50 | (8) |
| Round | a | a | 60 | (1) |

[a]Insufficient data

Table C-75.

Percentage of Total Labor for Footing and/or Stub Post Installation of the Most Widely Used Multiple Post Sign Systems, by Type of Post

| Type of Post Material/ Cross-Sectional Shape | Percentage of Total Labor | | | Total Systems |
|---|---|---|---|---|
| | Percentile Value 25th | Percentile Value 75th | Median Value | |
| | - - - - | -Percent- | - - - - | (Number) |
| Steel | | | | |
| "U" Single | 16 | 70 | 50 | (4) |
| Square or Rectangular Tube | 40 | 53 | 50 | (5) |
| Round or Oval Pipe | 50 | 90 | 70 | (2) |
| Beam (I, S, W, or H) | 50 | 75 | 60 | (13) |
| Angle (Z) | a | a | 25 | (1) |
| Aluminum | | | | |
| "U" Single | a | a | 55 | (1) |
| Square or Rectangular Tube | a | a | 90 | (1) |
| Round or Oval Pipe | 1 | 55 | 14 | (5) |
| Wood | | | | |
| Square or Rectangular | 42 | 73 | 65 | (8) |
| Round | 50 | 50 | 50 | (2) |

[a]Insufficient data

Table C-76.

Percentage of Total Labor for Support Post Installation of Selected Single Post Sign Systems, by Type of Post and Use of Footing or Stub Post

| Type of Post/Use of Footing or Stub Post | Percentage of Total Labor: Percentile Value 25th | Percentage of Total Labor: Percentile Value 75th | Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - - Percent | | - - - - - | (Number) |
| With Footing/Stub Post | | | | |
| Steel "U" Single | 15 | 33 | 20 | (14) |
| Steel Square or Rectangular Tube | 25 | 35 | 33 | (10) |
| Steel Round or Oval Pipe | 10 | 25 | 20 | (18) |
| Wood Square or Rectangular | 14 | 38 | 20 | (7) |
| Wood Round | a | a | 5 | (1) |
| Without Footing/Stub Post | | | | |
| Steel "U" Single | 50 | 80 | 75 | (40) |
| Steel Square or Rectangular Tube | 40 | 61 | 50 | (9) |
| Steel Round or Oval Pipe | 61 | 84 | 80 | (7) |
| Wood Square or Rectangular | 50 | 79 | 70 | (19) |
| Wood Round | a | a | 75 | (1) |

[a]Insufficient data.

Table C-77.

Percentage of Total Labor for Support Post Installation of Selected Multiple Post Sign Systems, by Type of Post and Use of Footing or Stub Post

| Type of Post/Use of Footing or Stub Post | Percentage of Total Labor | | | Total Systems |
|---|---|---|---|---|
| | Percentile Value | | Median Value | |
| | 25th | 75th | | |
| | - - - - - Percent | - - - - - | | (Number) |
| With Footing/Stub Post | | | | |
| Steel "U" Single | 13 | 17 | 15 | (4) |
| Steel Square or Rectangular Tube | 29 | 40 | 34 | (5) |
| Steel Round or Oval Pipe | 16 | 33 | 25 | (2) |
| Steel Beam (I,S,W, or H) | 13 | 29 | 25 | (11) |
| Wood Square or Rectangular | 15 | 29 | 15 | (7) |
| Wood Round | 9 | 11 | 10 | (2) |
| Without Footing/Stub Post | | | | |
| Steel "U" Single | 58 | 83 | 75 | (17) |
| Steel Square or Rectangular Tube | 28 | 75 | 49 | (4) |
| Steel Round or Oval Pipe | a | a | 80 | (1) |
| Steel Beam (I,S,W, or H) | a | a | a | (0) |
| Wood Square or Rectangular | 73 | 80 | 75 | (13) |
| Wood Round | a | a | a | (0) |

[a]Insufficient data.

Table C-78.

Percentage of Total Labor for Sign Panel Installation of Selected Single Post Sign Systems by Type of Post and Use of Footing or Stub Post

| Type of Post/Use of Footing or Stub Post | Percentage of Total Labor: Percentile Value 25th | Percentage of Total Labor: Percentile Value 75th | Percentage of Total Labor: Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - - Percent | | - - - - - | (Number) |
| With Footing/Stub Post | | | | |
| Steel "U" Single | 17 | 30 | 25 | (14) |
| Steel Square or Rectangular Tube | 15 | 33 | 23 | (10) |
| Steel Round or Oval Pipe | 8 | 29 | 25 | (20) |
| Steel Beam (I,S,W, or H) | 12 | 15 | 14 | (2) |
| Wood Square or Rectangular | 10 | 20 | 11 | (8) |
| Wood Round | a | a | 35 | (1) |
| Without Footing/Stub Post | | | | |
| Steel "U" Single | 15 | 34 | 25 | (34) |
| Steel Square or Rectangular Tube | 29 | 43 | 40 | (9) |
| Steel Round or Oval Pipe | 16 | 35 | 20 | (7) |
| Steel Beam (I,S,W, or H) | a | a | a | (0) |
| Wood Square or Rectangular | 20 | 39 | 25 | (19) |
| Wood Round | a | a | 20 | (1) |

[a] Insufficient data.

Table C-79.

Percentage of Total Labor for Sign Panel Installation of Selected Multiple Post Sign Systems, by Type of Post and Use of Footing or Stub Post

| Type of Post/Use of Footing or Stub Post | Percentage of Total Labor | | | Total Systems |
|---|---|---|---|---|
| | Percentile Value | | Median Value | |
| | 25th | 75th | | |
| | - - - - - Percent - - - - - | | | (Number) |
| With Footing/Stub Post | | | | |
| Steel "U" Single | 20 | 23 | 20 | (4) |
| Steel Square or Rectangular Tube | 15 | 21 | 20 | (5) |
| Steel Round or Oval Pipe | 5 | 25 | 15 | (2) |
| Steel Beam (I,S,W, or H) | 14 | 26 | 17 | (13) |
| Wood Square or Rectangular | 10 | 21 | 15 | (8) |
| Wood Round | 35 | 35 | 35 | (2) |
| Without Footing/Stub Post | | | | |
| Steel "U" Single | 11 | 39 | 20 | (19) |
| Steel Square or Rectangular Tube | 25 | 57 | 44 | (4) |
| Steel Round or Oval Pipe | a | a | 20 | (1) |
| Steel Beam (I,S,W, or H) | a | a | a | (0) |
| Wood Square or Rectangular | 20 | 27 | 25 | (13) |
| Wood Round | a | a | a | (0) |

[a]Insufficient data.

the total labor required to install the whole sign system. Systems using aluminum pipe posts apparently do not require nearly so much labor to install footings and/or stub posts as do systems using other types of posts.

Tables C-76 and C-77 show the percentages of total labor required for support post installation on single and multiple post sign systems with and without footings and/or stub posts. As can be seen, there is a considerable difference in the percentages of total labor required to install support posts between systems with footings and/or stub posts and systems without footings and/or stub posts.

Tables C-78 and C-79 show the percentages of total labor required for sign panel installation on single and multiple post systems with and without footings and/or stub posts. In the case of sign panel installation, the differences in the percentages are not too great between systems with footings and/or stub post and those without them. Also, the differences in the percentages are very small between single post and multiple post systems regardless of the use of footings and/or stub posts.

## Material Unit Costs

The respondents were requested to furnish unit costs of various spare parts required for their most widely used sign support systems. They were instructed to provide the material cost data in units that they thought appropriate, such as dollars/pound, dollars/ft., etc. Also, they were to assume that these spare parts were purchased in lots large enough to supply 100 signs.

Giving the respondents the liberty to report the material unit costs in units that they thought appropriate was a mistake. The following units were used to report these costs: dollars/sign, dollars/post, dollars/ft., dollars/sq. ft., dollars/cu. ft., and dollars/lb. The respondents should have been told the appropriate unit to use for a given component of the sign systems. For example, the sign panel information should have been requested in dollars/sq. ft. Since the respondents reported the costs in different units, it was very difficult or impossible to aggregate the data for presentation in this report. Finally, it was concluded that no conversions would be attempted and that only data reported in the most commonly used unit would be aggregated for presentation.

### Footing Unit Cost

Very few respondents reported footing unit costs. For those who did, few reported them in the same units. The most common unit used was dollars/cu. ft., but there were usually no more than two systems using a particular type of support post reported in the same units. Only those single post systems using steel round or oval pipe posts have as many as five systems reported in dollars/cu. ft. In this case, the median unit cost is $20/cu. ft. for the footing. The unit costs reported for systems using other types of support posts are much higher, with the most commonly quoted cost being $225/cu. ft. for both single and multiple post sign systems.

Stub Post Unit Cost

Stub post unit costs were reported more frequently than the footing unit costs. As a result, enough data are available to present in tabular form. Table C-80 shows the stub post unit costs in dollars/ft. for single and multiple post systems using various types of support post. Stub posts for sign systems using steel "U" single support posts and steel tube support posts cost the least, and stub posts for sign systems using steel beam support posts cost the most.

Support Post Unit Cost

Since all sign systems use a support post, support unit costs were reported by most of the respondent government agencies for the most commonly used sign systems. A few of the sign suppliers reported their support post unit prices (costs).

Reported by Government Agencies - Table C-81 shows a summary of the support post unit costs reported by the responding government agencies. Except for the steel beam or angle type of support posts, the unit costs of support posts used on the single post sign systems are about the same as those of support posts used on the multiple sign systems. Table C-81 shows also that support posts of the steel "U" single or wood square or rectangular types have the lowest unit costs.

Table C-82 shows the support post unit costs for selected sign systems by type of respondent. Apparently, state agencies pay more than other agencies for support posts made of the same type of material and cross-sectional shape.

Table C-80.

Unit Cost of Stub Posts of the Most Widely Used Sign Systems, by Type of Sign and Type of Post

| Type of Sign/Post | Unit Cost of Stub Post: Percentile Value 25th | 75th | Median Value | Total Systems |
|---|---|---|---|---|
| | ------ | $/Ft. | ------ | (Number) |
| Single Post Signs | | | | |
| Steel "U" Single | 0.82 | 1.14 | 1.00 | (11) |
| Steel "U" Back to Back | a | a | 1.75 | (1) |
| Steel Square or Rectangular Tube | 1.23 | 2.03 | 1.63 | (2) |
| Steel Round or Oval Pipe | 1.14 | 1.14 | 1.14 | (3) |
| Wood Square or Rectangular | a | a | 1.25 | (1) |
| Multiple Post Signs | | | | |
| Steel "U" Single | 0.94 | 1.14 | 1.00 | (7) |
| Steel "U" Back to Back | a | a | 1.75 | (1) |
| Steel Beam (I, S, W, H) | 3.63 | 18.95 | 12.00 | (5) |
| Steel Square or Rectangular Tube | 1.14 | 1.23 | 0.66 | (3) |
| Wood Square or Rectangular | a | a | 1.25 | (1) |

[a]Insufficient data

$1/ft = $3.28/m

Table C-81.

Unit Cost of Support Posts of the Most Widely Used Sign Systems, by Type of Sign and Type of Post

| Type of Sign/Post | Unit Cost of Support Post: Percentile Value 25th | 75th | Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - - - - $/Ft. | - - - - - - - | | (Number) |
| Single Post Signs | | | | |
| Steel "U" Single | 0.60 | 1.00 | 0.80 | (35) |
| Steel "U" Back to Back | a | a | 1.73 | (2) |
| Steel Square or Rectangular Tube | 0.75 | 1.88 | 1.50 | (9) |
| Steel Round or Oval Pipe | 0.86 | 1.75 | 1.14 | (14) |
| Steel Beam (I, S, W, H) | a | a | 25.00 | (1) |
| Aluminum Round or Oval Pipe | a | a | 1.10 | (3) |
| Aluminum Beam (I, S, W, H) | a | a | 1.90 | (1) |
| Wood Square or Rectangular | 0.43 | 0.90 | 0.60 | (29) |
| Multiple Post Signs | | | | |
| Steel "U" Single | 0.65 | 1.00 | 0.80 | (18) |
| Steel "U" Back to Back | a | a | 1.73 | (2) |
| Steel Square or Rectangular Tube | a | a | 1.13 | (2) |
| Steel Round or Oval Pipe | 0.86 | 1.88 | 1.75 | (6) |
| Steel Beam (I, S, W, H) | 1.14 | 13.40 | 4.56 | (9) |
| Steel Angle (Z) | a | a | 10.00 | (1) |
| Aluminum Round or Oval Pipe | a | a | 1.35 | (3) |
| Wood Square or Rectangular | 0.50 | 1.60 | 0.65 | (25) |

[a] Insufficient data

$1/ft = $3.28/m

Table C-82.

Unit Cost of Support Posts of Selected Sign Systems, by Type of Sign, Type of Post, and Type of Respondent

| Type of Sign/Post/ Respondent | Unit Cost of Support Post | | | Total Systems |
|---|---|---|---|---|
| | Percentile Value | | Median Value | |
| | 25th | 75th | | |
| | - - - - - - $/Ft. - - - - - - | | | (Number) |
| Single Post Signs | | | | |
| State Agencies | | | | |
| Steel "U" Single | 0.65 | 1.00 | 0.85 | (19) |
| Steel Round or Oval Pipe | 1.14 | 1.75 | 1.14 | (8) |
| Wood Square or Rectangular | 0.44 | 1.60 | 0.62 | (16) |
| Other Agencies | | | | |
| Steel "U" Single | 0.58 | 0.92 | 0.61 | (16) |
| Steel Round or Oval Pipe | 0.30 | 1.70 | 0.92 | (6) |
| Wood Square or Rectangular | 0.42 | 0.71 | 0.60 | (13) |
| Multiple Post Signs | | | | |
| State Agencies | | | | |
| Steel "U" Single | 0.65 | 0.85 | 0.80 | (12) |
| Wood Square or Rectangular | 0.47 | 2.40 | 0.86 | (15) |
| Other Agencies | | | | |
| Steel "U" Single | 0.61 | 1.10 | 0.97 | (6) |
| Wood Square or Rectangular | 0.50 | 0.65 | 0.60 | (10) |

$1/ft = $3.28/m

Size of support post may account for part of the differences in cost. However, cross-tabulations by size spread the data too thin and therefore could not be used to confirm this hypothesis.

Table C-83 shows the unit costs of steel "U" single support posts used on single post systems by region. The cost of such a post is shown to vary considerably from region to region.

Reported by Sign Supplier. Several of the respondent sign suppliers reported their unit prices for various types and sizes of support posts that they sell to government agencies and to sign contractors. These prices are shown in Tables C-84 and C-85. As can be seen, these unit prices vary considerably depending on the type of post material, size, and quantity (linear feet) purchased.

Sign Panel Unit Cost

Like support posts, every sign system must have a sign panel; therefore, the respondents reported sign panel unit costs for most of their sign systems. The sign panel unit costs for single and multiple post sign systems using various types of support posts are shown in Table C-86. The unit costs vary considerably by the type of support post used. Perhaps the differences in unit costs are explained by the type of material used to make the sign blanks. Table C-87 shows that there are considerable differences in the unit costs of sign blanks made of various materials.

Table C-88 shows the sign panel unit costs for the different types of signs and posts by type of respondent. As can be seen, sign panel unit costs are about the same for state and other agencies. However, sign panel unit costs do vary from region to region, as is shown in Table C-89.

Table C-83.

Unit Cost of Steel "U" Single Support Posts of the Most Widely Used Single Post Systems, by Region

| Region | Unit Cost of Support Post: Percentile Value 25th | Unit Cost of Support Post: Percentile Value 75th | Unit Cost of Support Post: Median Value | Total Systems |
|---|---|---|---|---|
| | $/Ft. | $/Ft. | $/Ft. | (Number) |
| 1&2 | 0.60 | 1.01 | 0.63 | (10) |
| 3 | 0.50 | 0.81 | 0.75 | (3) |
| 4 | 0.75 | 1.25 | 1.00 | (2) |
| 5 | 0.80 | 0.85 | 0.83 | (12) |
| 6 | 0.50 | 1.10 | 0.58 | (3) |
| 7 | a | a | 3.00 | (1) |
| 8 | 0.30 | 1.00 | 0.92 | (3) |
| 9 | a | a | 0.75 | (1) |
| 10 | a | a | a | (0) |

[a] Insufficient data

$1/ft = $3.28/m

Table C-84

Unit Prices of "U" and "X" Type Support Posts
Furnished by Suppliers

| Post Material/Shape/Size | Unit Price 100 Ft. | 1000 Ft. | 5000 Ft. |
|---|---|---|---|
| | ---------------$/Ft.----------------- | | |
| Steel "U" Single | | | |
| 2.00 lbs/ft | 0.45[a] | 0.40[a] | 0.38[a,b] |
| 3.00 lbs/ft | 0.68[a] | 0.60[a] | 0.57[a,b] |
| Steel "U" Back to Back | | | |
| 6.00 lbs/ft | 1.35 | 1.21 | 1.14 |
| Aluminum "U" Single | | | |
| 3.00 lbs/ft (steel equiv.) | 1.27 | 1.18 | 1.00 |
| Aluminum "X" Single | | | |
| 2.00 lbs/ft (steel equiv.) | 1.07 | 0.99 | 0.83 |

[a]Based on painted posts. Galvanized posts are priced approximately 30 percent higher than painted posts.

[b]Average of quotes from two companies.

METRIC CONVERSION : 1 lb/ft = 1.49 kg/m
$1/ft = $3.28/m

Table C-85

Unit Prices of Steel Tube Type Support Posts
Furnished by a Supplier

| Post Size (in.) | Wall Thickness (in.) | Unit Price[a] | |
|---|---|---|---|
| | | Non-perforated | Perforated |
| | | -------------$/Ft------------- | |
| Square Cross Section | | | |
| 1 x 1 | 0.105 | 0.50 - 0.62 | -- |
| 1.25 x 1.25 | 0.105 | 0.58 - 0.72 | -- |
| 1.5 x 1.5 | 0.105 | 0.67 - 0.84 | 0.81 - 1.01 |
| 1.75 x 1.75 | 0.105 | 0.76 - 0.95 | 0.90 - 1.12 |
| 2 x 2 | 0.105 | 0.85 - 1.06 | 0.99 - 1.24 |
| 2.25 x 2.25 | 0.105 | 0.94 - 1.17 | 1.07 - 1.34 |
| 2.5 x 2.5 | 0.105 | 1.01 - 1.27 | 1.16 - 1.45 |
| 2.5 x 2.5 | 0.135 | 1.31 - 1.64 | 1.45 - 1.81 |
| Rectangular Cross Section | | | |
| 2 x 3 | 0.105 | 1.01 - 1.27 | 1.16 - 1.45 |

[a]For galvanized finish

METRIC CONVERSION : 1 ft = 0.305 m
1 in = 0.0254 m
$1/ft = $3.28/m

Table C-86.

Unit Cost of Sign Panels of the Most Widely Used Sign Systems, by Type of Sign and Type of Post

| Type of Sign/Post | Unit Cost of Sign Panel: Percentile Value 25th | Percentile Value 75th | Median Value | Total Systems |
|---|---|---|---|---|
| | ---- $/Sq. Ft. ---- | | | (Number) |
| Single Post Signs | | | | |
| Steel "U" Single | 2.32 | 3.40 | 2.87 | (31) |
| Steel "U" Back to Back | a | a | 2.81 | (2) |
| Steel Square or Rectangular Tube | 2.62 | 6.00 | 3.20 | (8) |
| Steel Round or Oval Pipe | 1.47 | 3.15 | 2.00 | (12) |
| Steel Beam (I, S, W, H) | a | a | 4.00 | (1) |
| Aluminum Square or Rectangular Tube | a | a | 2.50 | (1) |
| Aluminum Round or Oval Pipe | a | a | 4.12 | (2) |
| Aluminum Beam (I, S, W, H) | a | a | 5.00 | (1) |
| Wood Square or Rectangular | 3.40 | 5.60 | 4.00 | (29) |
| Multiple Post Signs | | | | |
| Steel "U" Single | 2.50 | 3.06 | 2.87 | (17) |
| Steel "U" Back to Back | a | a | 2.81 | (2) |
| Steel Square or Rectangular Tube | a | a | 5.00 | (3) |
| Steel Round or Oval Pipe | 3.15 | 15.00 | 4.67 | (6) |
| Steel Beam (I, S, W, H) | 1.90 | 8.63 | 7.00 | (11) |
| Steel Angle (Z) | a | a | 4.16 | (1) |
| Aluminum Round or Oval Pipe | 2.35 | 8.00 | 4.67 | (4) |
| Aluminum Beam (I, S, W, H) | a | a | 5.00 | (1) |
| Wood Square or Rectangular | 3.70 | 7.50 | 4.00 | (24) |

[a] Insufficient data

$\$1/ft^2 = \$10.75/m^2$

Table C-87.

Unit Cost of Sign Panels of the Most Widely Used Single Post Sign Systems, by Type of Material

| Type of Material | Unit Cost of Sign Panel | | | Total Systems |
|---|---|---|---|---|
| | Percentile Value | | Median Value | |
| | 25th | 75th | | |
| | - - - - - - - - $/Sq. Ft. - - - - - - - - | | | (Number) |
| Steel | 1.56 | 4.00 | 1.56 | (3) |
| Aluminum | 2.50 | 3.70 | 3.00 | (50) |
| Wood | 1.47 | 5.60 | 2.60 | (6) |
| Combination | 2.32 | 5.25 | 4.00 | (14) |

$\$1/ft^2 = \$10.75/m^2$

Table C-88.

Unit Cost of Sign Panels of Selected Sign Systems, by Type of Sign, Type of Post, and Type of Respondent

| Type of Sign/Post/ Respondent | Unit Cost of Sign Panel: Percentile Value 25th | 75th | Median Value | Total Systems |
|---|---|---|---|---|
| | ----- $/Sq. Ft. | | ----- | (Number) |
| Single Post Signs | | | | |
| State Agencies | | | | |
| Steel "U" Single | 2.32 | 3.40 | 2.75 | (19) |
| Wood Square or Rectangular | 3.40 | 6.00 | 4.00 | (17) |
| Other Agencies | | | | |
| Steel "U" Single | 2.00 | 3.00 | 2.87 | (12) |
| Wood Square or Rectangular | 3.25 | 5.25 | 4.00 | (12) |
| Multiple Post Signs | | | | |
| State Agencies | | | | |
| Steel "U" Single | 2.50 | 3.06 | 2.75 | (13) |
| Wood Square or Rectangular | 3.70 | 6.00 | 4.00 | (16) |
| Other Agencies | | | | |
| Steel "U" Single | 2.87 | 7.50 | 2.93 | (4) |
| Wood Square or Rectangular | 3.33 | 7.50 | 4.00 | (8) |

$\$1/ft^2 = \$10.75/m^2$

Table C-89.

Unit Cost of Sign Panels of the Most Widely Used Single Post Sign Systems, by Region

| Region | Unit Cost of Sign Panel: Percentile Value 25th | 75th | Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - - - - - | $/Sq. Ft. | - - - - - - - - | (Number) |
| 1&2 | 2.25 | 4.00 | 2.93 | (6) |
| 3 | 2.00 | 3.50 | 3.00 | (4) |
| 4 | 2.32 | 4.00 | 3.40 | (3) |
| 5 | 2.50 | 2.87 | 2.75 | (12) |
| 6 | 2.00 | 7.60 | 5.60 | (3) |
| 7 | a | a | 0.85 | (1) |
| 8 | a | a | 3.50 | (1) |
| 9 | a | a | 3.00 | (1) |
| 10 | a | a | a | (0) |

[a]Insufficient data

$\$1/ft^2 = \$10.75/m^2$

Miscellaneous Hardware Unit Cost

The unit costs of miscellaneous hardware (nuts, bolts, etc.) are shown in Table C-90 by type of sign and post. The miscellaneous hardware costs are shown to be much higher for multiple post signs than for single post signs, with the exception of sign systems using steel "U" single posts and steel pipe posts. Also miscellaneous hardware costs vary considerably by type of post material and post shape. Sign systems using steel "U" single posts and aluminum tube posts have the lowest miscellaneous hardware costs for single and multiple post signs.

Table C-90.

Unit Cost of Miscellaneous Hardware of the Most Widely Used Sign Systems, by Type of Sign and Type of Post Material

| Type of Sign/Post Material | Unit Cost of Hardware: Percentile Value 25th | Percentile Value 75th | Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - - $/Sign | | - - - - - | (Number) |
| Single Post Signs | | | | |
| Steel "U" Single | 0.25 | 1.00 | 0.50 | (50) |
| Steel "U" Back to Back | a | a | 0.30 | (1) |
| Steel Square or Rectangular Tube | 0.50 | 1.00 | 0.60 | (16) |
| Steel Round or Oval Pipe | 1.00 | 3.00 | 2.31 | (24) |
| Steel Beam (I, S, W, H) | 1.00 | 10.69 | 3.90 | (3) |
| Aluminum Square or Rectangular Tube | a | a | 0.15 | (1) |
| Aluminum Round or Oval Pipe | 0.25 | 25.00 | 2.08 | (4) |
| Wood Square or Rectangular | 0.50 | 1.00 | 1.00 | (23) |
| Multiple Post Signs | | | | |
| Steel "U" Single | 0.40 | 1.50 | 0.75 | (23) |
| Steel "U" Back to Back | a | a | 2.00 | (2) |
| Steel Square or Rectangular Tube | 0.36 | 2.00 | 1.60 | (9) |
| Steel Round or Oval Pipe | 0.30 | 6.00 | 2.00 | (3) |
| Steel Beam (I, S, W, H) | 6.00 | 21.38 | 12.80 | (12) |
| Aluminum Square or Rectangular Tube | a | a | 0.30 | (1) |
| Aluminum Round or Oval Pipe | 0.50 | 50.00 | 5.00 | (6) |
| Wood Square or Rectangular | 1.00 | 6.50 | 3.00 | (21) |

[a] Insufficient data

## Collision Repair Information

The selection of the most cost-effective sign support system should include consideration of the costs, manpower requirements, and special equipment requirements to repair signs struck by motor vehicles. Therefore, the respondents were asked to furnish collision repair information on each of their most widely used sign systems. They were asked to exclude all costs resulting from normal maintenance (cleaning, vandalism repair, etc.) and to furnish information based on an "average" or typical collision. It was suggested that, ideally, such information could be obtained by averaging the records from a number of accidents for each sign system. If such records were not available, the respondents were asked to give their "best" estimates (obtained from maintenance personnel).

The collision repair data was obtained on a complete system (per sign) basis and on a component parts basis. In addition, the special equipment needed to repair all or parts of a system was identified.

### Complete System Data

Data obtained on a complete system basis is as follows: (1) estimated total cost to repair sign system (dollars per sign), (2) percentage of total repair cost (dollars per sign) due to labor, and (3) estimated total labor (man-hours per sign) to repair sign system.

Total Repair Cost - Tables C-91 and C-92 show the total costs to repair the most widely used single and multiple post sign systems by type of support post. As can be seen, the total repair cost of multiple post signs is about double that of single post signs, regardless of the type of support post used. Sign systems using steel beam posts and aluminum pipe posts have

Table C-91.

Total Cost to Repair the Most Widely Used Single Post Sign Systems, by Type of Post

| Type of Post Material/ Cross-Sectional Shape | Total Repair Cost | | | Total Systems |
|---|---|---|---|---|
| | Percentile Value | | Median Value | |
| | 25th | 75th | | |
| | - - - - - - $/Sign - - - - - - | | | (Number) |
| Steel | | | | |
| "U" Single | 20 | 40 | 28 | (51) |
| Square or Rectangular Tube | 20 | 41 | 23 | (17) |
| Round or Oval Pipe | 17 | 42 | 27 | (28) |
| Beam (I, S, W, or H) | a | a | 80 | (1) |
| Aluminum | | | | |
| Square or Rectangular Tube | a | a | 16 | (1) |
| Round or Oval Pipe | 22 | 475 | 87 | (4) |
| Wood | | | | |
| Square or Rectangular | 24 | 59 | 45 | (25) |
| Round | a | a | 30 | (1) |

[a] Insufficient data

Table C-92.

Total Cost to Repair the Most Widely Used Multiple Post Sign Systems, by Type of Post

| Type of Post Material/ Cross-Sectional Shape | Total Repair Cost: Percentile Value 25th | Total Repair Cost: Percentile Value 75th | Total Repair Cost: Median Value | Total Systems |
|---|---|---|---|---|
| | $/Sign | | | (Number) |
| Steel | | | | |
| "U" Single | 42 | 94 | 50 | (19) |
| "U" Back to Back | a | a | 153 | (1) |
| Square or Rectangular Tube | 41 | 98 | 50 | (7) |
| Round or Oval Pipe | 4 | 49 | 28 | (5) |
| Beam (I, S, W, or H) | 49 | 752 | 150 | (15) |
| Aluminum | | | | |
| Square or Rectangular Tube | a | a | 24 | (1) |
| Round or Oval Pipe | 80 | 503 | 135 | (5) |
| Wood | | | | |
| Square or Rectangular | 49 | 169 | 87 | (23) |
| Round | 75 | 82 | 79 | (2) |

[a] Insufficient data

considerably higher repair costs than do systems using other types of support posts.

Table C-93 shows the total cost to repair the most widely used sign systems by type of respondent. With the exception of sign systems using wood posts, state agencies pay more to repair single post signs than do other agencies. For multiple post signs, the reverse is true.

Table C-94 shows the total cost to repair single post systems with steel "U" single support posts by region. These results show that the total repair cost of such sign systems varies considerably from region to region.

Percentage of Total Cost Due to Labor. Tables C-95 and C-96 give the percentage of total repair cost due to labor for the most widely used single and multiple post signs by type of support post. There is considerable variation in labor repair cost percentages between the single and multiple post systems having the same support posts. Also, there are considerable differences in the labor repair cost percentages among the systems with various types of support posts. The percentages of total repair cost due to labor vary from 10 to 55 percent.

Tables C-97 and C-98 show the labor repair cost percentages vary significantly by type of respondent. The percentages for state agencies are usually higher than those for other agencies.

Total Labor Used. Tables C-99 and C-100 give the total labor (man-hours per sign) used for repairing the most widely used single and multiple post sign systems by type of support post. There is considerable variation in the man-hours required to repair systems with different types of support posts. Those with steel beam posts and wood posts require

Table C-93.

Total Cost to Repair the Most Widely Used Sign Systems by Type of Sign, Type of Post, and Type of Respondent

| Type of Sign/Post/ Respondent | Total Repair Cost: Percentile Value 25th | Total Repair Cost: Percentile Value 75th | Total Repair Cost: Median Value | Total Systems |
|---|---|---|---|---|
| | $/Sign | | | (Number) |
| Single Post Signs | | | | |
| State Agencies | | | | |
| Steel "U" Single | 19 | 45 | 40 | (19) |
| Steel Square or Rectangular Tube | 17 | 64 | 38 | (8) |
| Steel Round or Oval Pipe | 14 | 54 | 34 | (10) |
| Wood Square or Rectangular | 16 | 57 | 30 | (15) |
| Other Agencies | | | | |
| Steel "U" Single | 20 | 36 | 27 | (32) |
| Steel Square or Rectangular Tube | 20 | 28 | 21 | (9) |
| Steel Round or Oval Pipe | 20 | 33 | 25 | (18) |
| Wood Square or Rectangular | 40 | 60 | 53 | (10) |
| Multiple Post Signs | | | | |
| State Agencies | | | | |
| Steel "U" Single | 45 | 69 | 50 | (8) |
| Steel Square or Rectangular Tube | 62 | 427 | 93 | (4) |
| Wood Square or Rectangular | 41 | 165 | 74 | (19) |
| Other Agencies | | | | |
| Steel "U" Single | 40 | 118 | 52 | (11) |
| Steel Square or Rectangular Tube | 36 | 48 | 42 | (3) |
| Wood Square or Rectangular | 83 | 179 | 134 | (4) |

Table C-94.

Total Cost to Repair Steel "U" Single Posts of the Most Widely Used Single Post Sign Systems, by Region

| Region | Total Repair Cost: Percentile Value 25th | Total Repair Cost: Percentile Value 75th | Total Repair Cost: Median Value | Total Systems |
|---|---|---|---|---|
| | $/Sign | | | (Number) |
| 1&2 | 19 | 38 | 29 | (12) |
| 3 | 40 | 83 | 43 | (6) |
| 4 | 20 | 46 | 25 | (6) |
| 5 | 21 | 35 | 27 | (10) |
| 6 | 15 | 35 | 17 | (4) |
| 7 | 20 | 27 | 20 | (7) |
| 8 | 16 | 40 | 30 | (4) |
| 9 | a | a | 33 | (1) |
| 10 | a | a | 30 | (1) |

[a]Insufficient data

Table C-95.

Percentage of Total Cost for Labor to Repair the Most Widely Used Single Post Sign Systems, by Type of Post

| Type of Post Material/ Cross-Sectional Shape | Percentage of Total Cost | | | Total Systems |
|---|---|---|---|---|
| | Percentile Value | | Median Value | |
| | 25th | 75th | | |
| | - - - - - - Percent - - - - - - | | | (Number) |
| Steel | | | | |
| "U" Single | 20 | 47 | 33 | (49) |
| Square or Rectangular Tube | 23 | 47 | 30 | (16) |
| Round or Oval Pipe | 25 | 50 | 40 | (26) |
| Beam (I, S, W, or H) | a | a | 37 | (1) |
| Aluminum | | | | |
| Square or Rectangular Tube | a | a | 48 | (1) |
| Round or Oval Pipe | 30 | 64 | 55 | (4) |
| Wood | | | | |
| Square or Rectangular | 30 | 50 | 43 | (24) |
| Round | a | a | 50 | (1) |

[a]Insufficient data

Table C-96.

Percentage of Total Cost for Labor to Repair the Most Widely Used Multiple Post Sign Systems, by Type of Post

| Type of Post Material/ Cross-Sectional Shape | Percentage of Total Cost: Percentile Value 25th | 75th | Median Value | Total Systems |
|---|---|---|---|---|
| | ------ Percent | | ------ | (Number) |
| Steel | | | | |
| "U" Single | 20 | 35 | 26 | (18) |
| "U" Back to Back | a | a | 28 | (1) |
| Square or Rectangular Tube | 22 | 54 | 34 | (7) |
| Round or Oval Pipe | 28 | 53 | 50 | (5) |
| Beam (I, S, W, or H) | 30 | 65 | 48 | (15) |
| Aluminum | | | | |
| "U" Single | a | a | 13 | (1) |
| Square or Rectangular Tube | a | a | 32 | (1) |
| Round or Oval Pipe | 8 | 13 | 10 | (5) |
| Wood | | | | |
| Square or Rectangular | 30 | 50 | 44 | (22) |
| Round | 36 | 40 | 38 | (2) |

[a]Insufficient data

Table C-97.

Percentage to Total Cost for Labor to Repair the Most Widely Used Single Post Sign Systems, by Type of Sign and Type of Respondent

| Type of Respondent/ Type of Post | Percentage of Total Cost: Percentile Value 25th | Percentile Value 75th | Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - - - Percent | - - - - - - | | (Number) |
| State Agencies | | | | |
| Steel | | | | |
| "U" Single | 23 | 48 | 38 | (19) |
| Square or Rectangular Tube | 23 | 65 | 50 | (7) |
| Round or Oval Pipe | 32 | 68 | 50 | (9) |
| Aluminum | | | | |
| Round or Oval Pipe | 20 | 63 | 50 | (3) |
| Wood | | | | |
| Square or Rectangular | 23 | 50 | 47 | (15) |
| Other Agencies | | | | |
| Steel | | | | |
| "U" Single | 18 | 47 | 29 | (30) |
| Square or Rectangular Tube | 24 | 33 | 30 | (9) |
| Round or Oval Pipe | 23 | 43 | 40 | (17) |
| Aluminum | | | | |
| Round or Oval Pipe | a | a | 60 | (1) |
| Wood | | | | |
| Square or Rectangular | 36 | 52 | 40 | (9) |

[a] Insufficient data

Table C-98.

Percentage of Total Cost for Labor to Repair Selected Multiple Post Sign Systems, by Type of Post and Type of Respondent

| Type of Respondent/ Type of Post | Percentage of Total Cost: Percentile Value 25th | Percentile Value 75th | Median Value | Total Systems |
|---|---|---|---|---|
| | ------ Percent | | ------ | (Number) |
| State Agencies | | | | |
| Steel | | | | |
| "U" Single | 21 | 40 | 34 | (8) |
| Square or Rectangular Tube | 16 | 65 | 43 | (4) |
| Round or Oval Pipe | 50 | 58 | 50 | (3) |
| Aluminum | | | | |
| Round or Oval Pipe | 10 | 18 | 10 | (3) |
| Wood | | | | |
| Square or Rectangular | 26 | 50 | 44 | (19) |
| Other Agencies | | | | |
| Steel | | | | |
| "U" Single | 20 | 33 | 25 | (10) |
| Square or Rectangular Tube | 24 | 35 | 34 | (3) |
| Round or Oval Pipe | 27 | 28 | 28 | (2) |
| Aluminum | | | | |
| Round or Oval Pipe | 8 | 6 | 7 | (2) |
| Wood | | | | |
| Square or Rectangular | 41 | 45 | 43 | (3) |

Table C-99.

Total Labor Used for Repairing the Most Widely Used Single Post Sign Systems, by Type of Post

| Type of Post Material/ Cross-Sectional Shape | Total Labor: Percentile Value 25th | Total Labor: Percentile Value 75th | Total Labor: Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - Man-Hours/Sign | | - - - - | (Number) |
| Steel | | | | |
| "U" Single | 0.7 | 2.0 | 1.0 | (49) |
| Square or Rectangular Tube | 1.0 | 1.5 | 1.0 | (15) |
| Round or Oval Pipe | 1.0 | 2.0 | 1.0 | (26) |
| Beam (I, S, W, or H) | a | a | 6.0 | (1) |
| Aluminum | | | | |
| Square or Rectangular Tube | a | a | 0.8 | (1) |
| Round or Oval Pipe | 1.3 | 5.0 | 1.8 | (4) |
| Wood | | | | |
| Square or Rectangular | 1.0 | 3.5 | 1.5 | (24) |
| Round | a | a | 2.0 | (1) |

[a]Insufficient data

Table C-100.

Total Labor Used to Repair the Most Widely Used Multiple Post Sign Systems, by Type of Sign

| Type of Post Material/ Cross-Sectional Shape | Total Labor: Percentile Value 25th | Total Labor: Percentile Value 75th | Total Labor: Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - Man-Hours/Sign | | - - - - | (Number) |
| Steel | | | | |
| "U" Single | 1.0 | 2.5 | 1.8 | (18) |
| Square or Rectangular Tube | 1.5 | 2.0 | 1.8 | (6) |
| Round or Oval Pipe | 0.3 | 2.6 | 1.0 | (5) |
| Beam (I, S, W, or H) | 5.0 | 14.6 | 8.0 | (15) |
| Aluminum | | | | |
| "U" Single | a | a | 2.0 | (1) |
| Square or Rectangular Tube | a | a | 1.0 | (1) |
| Round or Oval Pipe | 2.0 | 5.9 | 2.5 | (5) |
| Wood | | | | |
| Square or Rectangular | 2.0 | 6.0 | 3.7 | (22) |
| Round | 4.0 | 4.0 | 4.0 | (2) |

[a]Insufficient data

much more labor than those with other types of support posts. Also, multiple post systems require about twice as many man-hours to repair as do single post systems.

Tables C-101 and C-102 show that the labor required for repairing most sign systems is about the same for the state agency as for others. As shown in Table C-103, the total labor required to repair single post sign systems with steel "U" single support posts varies considerably by region. Region 4 requires the least labor and Region 7 the most.

Unit Labor Cost. By converting the total labor repair cost percentages to dollars and dividing by the total man-hours of labor required to make repairs, the unit labor repair cost (dollars per man-hour) is obtained. Table C-104 shows the unit labor repair costs for the most widely used sign systems (single and multiple post systems combined) by type of respondent and by region. There is little variation by type of respondent but there is considerable variation by region. The unit labor costs in Regions 3 and 10 are very high and they are low in Regions 1&2 and 7.

## Component Parts of System Data

The respondents were asked to estimate the percentages of sign repair jobs that involved complete, specific parts or no replacement for each sign system.

Replacement of Complete System. The percentages of sign repair jobs involving complete replacement of the sign system for single and multiple post systems are shown in Table C-105. These percentages vary extremely (from one to 100 percent) among sign systems with different

Table C-101

Total Labor Used to Repair Selected Single Post Sign Systems, by Type of Post and Type of Respondent

| Type of Post Respondent/ Type of Post | Total Labor: Percentile Value 25th | Total Labor: Percentile Value 75th | Total Labor: Median Value | Total Systems |
|---|---|---|---|---|
| | - - - -Man-Hrs/Sign - - - - | | | (Number) |
| State Agencies | | | | |
| Steel | | | | |
| "U" Single | 1.0 | 2.0 | 1.0 | (19) |
| Square or Rectangular Tube | 0.7 | 1.5 | 1.0 | (7) |
| Round or Oval Pipe | 1.4 | 4.0 | 2.0 | (9) |
| Aluminum | | | | |
| Round or Oval Pipe | 1.6 | 6.5 | 2.0 | (3) |
| Wood | | | | |
| Square or Rectangular | 0.7 | 3.5 | 2.0 | (15) |
| Other Agencies | | | | |
| Steel | | | | |
| "U" Single | 0.6 | 2.0 | 1.0 | (30) |
| Square or Rectangular Tube | 1.0 | 1.8 | 1.0 | (8) |
| Round or Oval Pipe | 0.7 | 2.0 | 1.0 | (17) |
| Aluminum | | | | |
| Round or Oval Pipe | a | a | 1.0 | (1) |
| Wood | | | | |
| Square or Rectangular | 1.0 | 3.5 | 1.5 | (9) |

[a] Insufficient data.

Table C-102

Total Labor Used for Repairing Selected Multiple Post Sign Systems, by Type of Post and Type of Respondent

| Type of Respondent/ Type of Post | Total Labor | | | |
|---|---|---|---|---|
| | Percentile Value | | Median Value | Total Systems |
| | 25th | 75th | | |
| | - - - -Man-Hrs/Sign - - - - | | | (Number) |
| State Agencies | | | | |
| Steel | | | | |
| "U" Single | 1.3 | 2.3 | 1.8 | (8) |
| Square or Rectangular Tube | 1.3 | 5.0 | 1.8 | (4) |
| Round or Oval Pipe | 0.3 | 5.7 | 0.3 | (3) |
| Aluminum | | | | |
| Round or Oval Pipe | 2.5 | 12.6 | 2.5 | (3) |
| Wood | | | | |
| Square or Rectangular | 2.0 | 4.5 | 3.5 | (19) |
| Other Agencies | | | | |
| Steel | | | | |
| "U" Single | 1.0 | 3.0 | 1.8 | (10) |
| Square or Rectangular Tube | 1.5 | 2.0 | 1.8 | (2) |
| Round or Oval Pipe | 1.0 | 1.0 | 1.0 | (2) |
| Aluminum | | | | |
| Round or Oval Pipe | 2.0 | 2.0 | 2.0 | (2) |
| Wood | | | | |
| Square or Rectangular | 4.8 | 11.5 | 10.0 | (3) |

Table C-103.

Total Labor Used to Repair Single Post Signs with Steel "U" Single Posts, by Region

| Region | Total Labor | | | Total Systems |
|---|---|---|---|---|
| | Percentile Value 25th | Percentile Value 75th | Median Value | |
| | - - - -Man-Hrs/Sign | | - - - - | (Number) |
| 1&2 | 0.6 | 1.9 | 1.0 | (11) |
| 3 | 1.0 | 1.5 | 1.0 | (6) |
| 4 | 0.5 | 4.5 | 0.6 | (6) |
| 5 | 1.0 | 2.0 | 1.3 | (10) |
| 6 | 0.9 | 1.1 | 1.0 | (5) |
| 7 | 0.8 | 2.9 | 2.0 | (6) |
| 8 | 0.5 | 1.8 | 1.0 | (4) |
| 9 | a | a | a | (0) |
| 10 | a | a | 1.0 | (1) |

[a] Insufficient data.

Table C-104.

Unit Labor Cost of Repairing the Most Widely Used Sign Systems, by Type of Respondent and Region[a]

| Type of Respondent/ Region | Unit Labor Cost[b] Percentile Value 25th | 75th | Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - - $/Man-Hour | | - - - - - | (Number) |
| Type of Respondent | | | | |
| State Agencies | 4.95 | 10.50 | 7.46 | (110) |
| Other | 5.03 | 11.20 | 6.67 | (87) |
| All | 4.99 | 10.74 | 7.06 | (197) |
| Region | | | | |
| 1&2 | 3.80 | 7.24 | 5.13 | (36) |
| 3 | 9.92 | 26.73 | 15.33 | (16) |
| 4 | 4.87 | 10.27 | 6.67 | (17) |
| 5 | 5.99 | 9.75 | 7.06 | (27) |
| 6 | 3.72 | 9.51 | 5.71 | (29) |
| 7 | 3.41 | 5.91 | 4.32 | (15) |
| 8 | 5.81 | 9.65 | 7.41 | (17) |
| 9 | 7.50 | 10.25 | 8.73 | (13) |
| 10 | 8.13 | 30.00 | 12.28 | (27) |

[a]Includes both single and multiple post systems.

[b]Based on total labor repair cost and totla labor for sign region.

Table C-105.

Percentage of Sign Repair Jobs That Replace the Complete Sign System, by Type of Sign and Type of Post

| Type of Sign/Post Material and Shape | Percentage of Repair Jobs: Percentile Value 25th | Percentile Value 75th | Median Value | Total Systems |
|---|---|---|---|---|
| | Percent | | | (Number) |
| Single Post Signs | | | | |
| Steel | | | | |
| "U" Single | 31 | 74 | 40 | (19) |
| Square or Rectangular Tube | 5 | 38 | 10 | (9) |
| Round or Oval Pipe | 2 | 78 | 16 | (19) |
| Beam (I, S, W, H) | a | a | 1 | (1) |
| Aluminum | | | | |
| Round or Oval Pipe | 6 | 28 | 20 | (3) |
| Wood | | | | |
| Square or Rectangular | 15 | 100 | 16 | (6) |
| Multiple Post Signs | | | | |
| Steel | | | | |
| "U" Single | 43 | 85 | 68 | (5) |
| Square or Rectangular Tube | 11 | 41 | 15 | (3) |
| Round or Oval Pipe | 5 | 61 | 5 | (3) |
| Beam (I, S, W, H) | 1 | 5 | 3 | (14) |
| Aluminum | | | | |
| Round or Oval Pipe | 38 | 52 | 50 | (5) |
| Wood | | | | |
| Square or Rectangular | 15 | 16 | 15 | (6) |

[a]Insufficient data

types of support posts. The percentages are especially high for "U" post systems. The variation is not as great between single and multiple post systems.

Replacement of Support Post Only. Tables C-107 and C-108 show the percentages of sign repair jobs which involve replacement of only the support post. Again, there is considerable variation among the systems with different types of support posts. Practically all of the single post systems show a higher percentage of repair jobs that replace only the support post than is the case of multiple post signs which are stronger.

Table C-108 shows that a higher percentage of the sign repair jobs of other agencies involve replacement of only the support post than is the case of state agencies.

Replacement of Sign Panel Only. As is shown in Table C-109, the percentages of sign repair jobs involving replacement of only the sign panel vary considerably among the different types of signs and types of support posts. Sign panel replacement percentages are usually higher for state agencies than for other agencies (Table C-110).

Replacement of Support Post and Sign Panel Only. The percentages of sign repair jobs requiring replacement of both the support posts and sign panel are shown in Table C-111. These percentages vary considerably among types of sign systems for both single and multiple post systems. As is usually the case, state agencies have somewhat higher percentages than do other agencies (Table C-112).

Table C-106.

Percentage of Sign Repair Jobs That Replace the Complete Sign System, by Type of Sign, Type of Post, and Type of Respondent

| Type of Sign/Post Respondent | Percentage of Repair Jobs: Percentile Value 25th | Percentile Value 75th | Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - - Percent | | - - - - - | (Number) |
| Single Post Signs | | | | |
| State Agencies | | | | |
| Steel "U" Single | 23 | 43 | 33 | (4) |
| Steel Square or Rectangular Tube | 9 | 31 | 20 | (3) |
| Steel Round or Oval Pipe | 2 | 17 | 5 | (9) |
| Wood Square or Rectangular | 10 | 16 | 15 | (4) |
| Other Agencies | | | | |
| Steel "U" Single | 33 | 79 | 45 | (15) |
| Steel Square or Rectangular Tube | 5 | 45 | 10 | (6) |
| Steel Round or Oval Pipe | 10 | 100 | 69 | (10) |
| Wood Square or Rectangular | 100 | 100 | 100 | (2) |
| Multiple Post Signs | | | | |
| State Agencies | | | | |
| Steel "U" Single | a | a | 50 | (1) |
| Steel Square or Rectangular Tube | 15 | 50 | 33 | (2) |
| Wood Square or Rectangular | 13 | 15 | 15 | (5) |
| Other Agencies | | | | |
| Steel "U" Single | 45 | 90 | 74 | (4) |
| Steel Square or Rectangular Tube | a | a | 10 | (1) |
| Wood Square or Rectangular | a | a | 100 | (1) |

[a] Insufficient data

Table C-107.

Percentage of Sign Repair Jobs that Replace Only the Support Post, by Type of Sign and Type of Post

| Type of Sign/Post Material and Shape | Percentage of Repair Jobs: Percentile Value 25th | Percentile Value 75th | Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - - Percent | | - - - - - | (Number) |
| Single Post Signs | | | | |
| Steel | | | | |
| "U" Single | 20 | 50 | 33 | (41) |
| Square or Rectangular Rube | 11 | 58 | 35 | (15) |
| Round or Oval Pipe | 10 | 40 | 30 | (22) |
| Beam (I,S,W, or H) | a | a | 40 | (1) |
| Aluminum | | | | |
| Square or Rectangular Tube | a | a | 60 | (1) |
| Round or Oval Pipe | 18 | 35 | 28 | (4) |
| Wood | | | | |
| Square or Rectangular | 35 | 80 | 55 | (22) |
| Round | a | a | 70 | (1) |
| Multiple Post Signs | | | | |
| Steel | | | | |
| "U" Single | 20 | 50 | 25 | (14) |
| Square or Rectangular Tube | 10 | 40 | 18 | (6) |
| Round or Oval Pipe | 18 | 40 | 40 | (5) |
| Beam (I,S,W, or H) | 5 | 50 | 25 | (16) |
| Aluminum | | | | |
| Square or Rectangular Tube | a | a | 40 | (1) |
| Round or Oval Pipe | 20 | 26 | 23 | (5) |
| Wood | | | | |
| Square or Rectangular | 10 | 76 | 45 | (18) |
| Round | 40 | 40 | 40 | (2) |

[a]Insufficient data.

Table C-108.

Percentage of Sign Repair Jobs that Replace Only the Support Post, by Type of Sign, Type of Post, and Type of Respondent

| Type of Sign/Post<br>Respondent | Percentage of Repair Jobs | | | |
|---|---|---|---|---|
| | Percentile Value | | Median Value | Total Systems |
| | 25th | 75th | | |
| | - - - - - Percent | - - - - - | | (Number) |
| Single Post Signs | | | | |
| State Agencies | | | | |
| Steel "U" Single | 17 | 50 | 33 | (18) |
| Steel Square or Rectangular Tube | 6 | 33 | 10 | (7) |
| Steel Round or Oval Pipe | 5 | 70 | 25 | (10) |
| Wood Square or Rectangular | 30 | 60 | 40 | (14) |
| Other Agencies | | | | |
| Steel "U" Single | 20 | 50 | 33 | (23) |
| Steel Square or Rectangular Tube | 33 | 68 | 43 | (8) |
| Steel Round or Oval Pipe | 20 | 40 | 30 | (12) |
| Wood Square or Rectangular | 65 | 97 | 80 | (8) |
| Multiple Post Signs | | | | |
| State Agencies | | | | |
| Steel "U" Single | 20 | 44 | 20 | (7) |
| Steel Square or Rectangular Tube | 7 | 18 | 10 | (4) |
| Steel Round or Oval Pipe | 18 | 40 | 40 | (3) |
| Wood Square or Rectangular | 10 | 63 | 38 | (16) |
| Other Agencies | | | | |
| Steel "U" Single | 18 | 58 | 45 | (7) |
| Steel Square or Rectangular Tube | 40 | 60 | 50 | (2) |
| Steel Round or Oval Pipe | 20 | 40 | 30 | (2) |
| Wood Square or Rectangular | 97 | 97 | 97 | (2) |

Table C-109.

Percentage of Sign Repair Jobs that Replace Only the Sign Panel, by Type of Sign and Type of Post

| Type of Sign/Post Material and Shape | Percentage of Repair Jobs: Percentile Value 25th | Percentage of Repair Jobs: Percentile Value 75th | Percentage of Repair Jobs: Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - - Percent | - - - - - | | (Number) |
| Single Post Signs | | | | |
| Steel | | | | |
| "U" Single | 5 | 15 | 10 | (37) |
| Square or Rectangular Tube | 8 | 21 | 11 | (12) |
| Round or Oval Pipe | 5 | 20 | 10 | (22) |
| Beam (I,S,W, Or H) | a | a | 13 | (1) |
| Aluminum | | | | |
| Square or Rectangular Tube | a | a | 5 | (1) |
| Round or Oval Pipe | 12 | 56 | 45 | (3) |
| Wood | | | | |
| Square or Rectangular | 1 | 15 | 10 | (19) |
| Round | a | a | 10 | (1) |
| Multiple Post Signs | | | | |
| Steel | | | | |
| "U" Single | 3 | 20 | 5 | (14) |
| Square or Rectangular Tube | 15 | 49 | 35 | (4) |
| Round or Oval Pipe | 8 | 19 | 15 | (5) |
| Beam (I,S,W, or H) | 5 | 13 | 7 | (16) |
| Aluminum | | | | |
| Square or Rectangular Tube | a | a | 10 | (1) |
| Round or Oval Pipe | 1 | 8 | 5 | (4) |
| Wood | | | | |
| Square or Rectangular | 4 | 25 | 10 | (16) |
| Round | 5 | 5 | 5 | (2) |

[a] Insufficient data.

Table C-110.

Percentage of Sign Repair Jobs that Replace Only the Sign Panel, by Type of Sign, Type of Post, and Type of Respondent

| Type of Sign/Post Respondent | Percentage of Repair Jobs: Percentile Value 25th | Percentile Value 75th | Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - - Percent | - - - - - | | (Number) |
| Single Post Signs | | | | |
| State Agencies | | | | |
| Steel "U" Single | 5 | 14 | 7 | (17) |
| Steel Square or Rectangular Tube | 10 | 35 | 15 | (5) |
| Steel Round or Oval Pipe | 5 | 15 | 9 | (10) |
| Wood Square or Rectangular | 9 | 18 | 10 | (12) |
| Other Agencies | | | | |
| Steel "U" Single | 5 | 15 | 10 | (20) |
| Steel Square or Rectangular Tube | 6 | 11 | 10 | (7) |
| Steel Round or Oval Pipe | 5 | 23 | 10 | (12) |
| Wood Square or Rectangular | 1 | 1 | 1 | (7) |
| Multiple Post Signs | | | | |
| State Agencies | | | | |
| Steel "U" Single | 4 | 20 | 5 | (8) |
| Steel Square or Rectangular Tube | 45 | 53 | 49 | (2) |
| Steel Round or Oval Pipe | 5 | 15 | 15 | (3) |
| Wood Square or Rectangular | 7 | 25 | 13 | (14) |
| Other Agencies | | | | |
| Steel "U" Single | 3 | 15 | 5 | (6) |
| Steel Square or Rectangular Tube | 5 | 25 | 15 | (2) |
| Steel Round or Oval Pipe | 10 | 30 | 20 | (2) |
| Wood Square or Rectangular | 1 | 1 | 1 | (2) |

Table C-111.

Percentage of Sign Repair Jobs that Replace Both Support Post and Sign Panel, by Type of Sign and Type of Post

| Type of Sign/Post Material and Shape | Percentage of Repair Jobs | | | Total Systems |
|---|---|---|---|---|
| | Percentile Value | | Median Value | |
| | 25th | 75th | | |
| | - - - - - Percent - - - - - | | | (Number) |
| Single Post Signs | | | | |
| Steel | | | | |
| "U" Single | 25 | 80 | 43 | (42) |
| Square or Rectangular Tube | 18 | 31 | 25 | (13) |
| Round or Oval Pipe | 5 | 35 | 23 | (20) |
| Beam (I,S,W, or H) | a | a | 10 | (1) |
| Aluminum | | | | |
| Square or Rectangular Tube | a | a | 35 | (1) |
| Round or Oval Pipe | 15 | 47 | 25 | (4) |
| Wood | | | | |
| Square or Rectangular | 7 | 52 | 25 | (21) |
| Round | a | a | 15 | (1) |
| Multiple Post Signs | | | | |
| Steel | | | | |
| "U" Single | 25 | 86 | 70 | (17) |
| "U" Back to Back | a | a | 100 | (1) |
| Square or Rectangular Tube | 18 | 43 | 20 | (5) |
| Round or Oval Pipe | 24 | 35 | 30 | (5) |
| Beam (I,S,W, or H) | 10 | 27 | 13 | (16) |
| Aluminum | | | | |
| Square or Rectangular Tube | a | a | 50 | (1) |
| Round or Oval Pipe | 25 | 58 | 51 | (5) |
| Wood | | | | |
| Square or Rectangular | 13 | 50 | 30 | (16) |
| Round | 50 | 50 | 50 | (2) |

[a]Insufficient data.

Table C-112.

Percentage of Sign Repair Jobs that Replace Both Support Post and Sign Panel by Type of Sign, Type of Post, and Type of Respondent

| Type of Sign/Post<br>Respondent | Percentage of Repair Jobs | | | Total Systems |
|---|---|---|---|---|
| | Percentile Value | | Median Value | |
| | 25th | 75th | | |
| | - - - - - Percent | | - - - - - | (Number) |
| Single Post Signs | | | | |
| State Agencies | | | | |
| Steel "U" Single | 25 | 70 | 43 | (18) |
| Steel Square or Rectangular Tube | 10 | 35 | 25 | (6) |
| Steel Round or Oval Pipe | 4 | 25 | 10 | (10) |
| Wood Square or Rectangular | 23 | 52 | 45 | (13) |
| Other Agencies | | | | |
| Steel "U" Single | 25 | 93 | 43 | (24) |
| Steel Square or Rectangular Tube | 20 | 29 | 25 | (7) |
| Steel Round or Oval Pipe | 20 | 35 | 33 | (10) |
| Wood Square or Rectangular | 1 | 34 | 7 | (8) |
| Multiple Post Signs | | | | |
| State Agencies | | | | |
| Steel "U" Single | 25 | 70 | 55 | (8) |
| Steel Square or Rectangular Tube | 21 | 78 | 25 | (3) |
| Steel Round or Oval Pipe | 11 | 30 | 30 | (3) |
| Wood Square or Rectangular | 20 | 50 | 30 | (14) |
| Other Agencies | | | | |
| Steel "U" Single | 32 | 100 | 80 | (9) |
| Steel Square or Rectangular Tube | 10 | 20 | 15 | (2) |
| Steel Round or Oval Pipe | 30 | 50 | 40 | (2) |
| Wood Square or Rectangular | 1 | 1 | 1 | (2) |

Repair Damaged Parts Only. Table C-113 shows the percentages of sign repair jobs, where only repairs of damaged parts (no replacement) are made for single and multiple post sign systems by type of support. Most of these percentages are very low and vary by type of post. There is little variation by type of sign (single versus multiple post).

Table C-114 shows that the state agency percentages of jobs where repair is made of only the damaged parts of sign systems are lower than those for other agencies.

Special Equipment Needed

The respondents were asked to identify any special equipment needed to replace and/or repair their sign systems. Table C-115 shows the types of equipment needed by type of sign and type of post. As can be seen, the special equipment needs are not very great for any of the sign systems. The number of no responses was high for all of the systems. Perhaps the special equipment needed most, regardless of type of sign or post, is some type of truck (lift truck, sign truck, or beam truck).

## Normal Maintenance Information

The respondents were asked to furnish normal maintenance information on each of their most widely used sign systems. They were instructed to exclude all maintenance costs due to vehicle sign collision repairs.

The specific data which the respondents were asked to furnish on each single and multiple post sign system is as follows: (1) estimated annual maintenance cost (dollars, per sign per year); (2) estimated annual labor (man-hours per sign per year) involved in maintenance; (3) estimated percentage of maintenance cost (dollars per sign) due to labor;

Table C-113.

Percentage of Sign Repair Jobs that Only Repair Damaged Parts (No Replacement), by Type of Sign and Type of Post

| Type of Sign/Post Material and Shape | Percentage of Repair Jobs | | | Total Systems |
|---|---|---|---|---|
| | Percentile Value | | Median Value | |
| | 25th | 75th | | |
| | - - - - - Percent | - - - - - | | (Number) |
| Single Post Signs | | | | |
| Steel | | | | |
| "U" Single | 5 | 10 | 5 | (33) |
| Square or Rectangular Tube | 5 | 14 | 5 | (13) |
| Round or Oval Pipe | 5 | 38 | 10 | (20) |
| Beam (I,S,W, or H) | a | a | 29 | (1) |
| Aluminum | | | | |
| Round or Oval Pipe | 3 | 5 | 5 | (4) |
| Wood | | | | |
| Square or Rectangular | 1 | 6 | 5 | (21) |
| Round | a | a | 5 | (1) |
| Multiple Post Signs | | | | |
| Steel | | | | |
| "U" Single | 5 | 15 | 5 | (13) |
| Square or Rectangular Tube | 3 | 18 | 8 | (4) |
| Round or Oval Pipe | 7 | 15 | 10 | (4) |
| Beam (I,S,W, or H) | 5 | 60 | 10 | (16) |
| Aluminum | | | | |
| Round or Oval Pipe | 3 | 15 | 4 | (5) |
| Wood | | | | |
| Square or Rectangular | 1 | 5 | 3 | (16) |
| Round | 5 | 5 | 5 | (2) |

[a]Insufficient data.

Table C-114.

Percentage of Sign Repair Jobs that Only Repair Damaged Parts (No Replacement), by Type of Sign, Type of Post, and Type of Respondent

| Type of Sign/Post Respondent | Percentage of Repair Jobs | | | Total Systems |
|---|---|---|---|---|
| | Percentile Value | | Median Value | |
| | 25th | 75th | | |
| | - - - - - Percent - - - - - | | | (Number) |
| Single Post Signs | | | | |
| State Agencies | | | | |
| Steel "U" Single | 4 | 5 | 5 | (15) |
| Steel Square or Rectangular Tube | 4 | 28 | 5 | (5) |
| Steel Round or Oval Pipe | 1 | 10 | 5 | (10) |
| Wood Square or Rectangular | 1 | 5 | 5 | (13) |
| Other Agencies | | | | |
| Steel "U" Single | 5 | 25 | 9 | (18) |
| Steel Square or Rectangular Tube | 5 | 18 | 7 | (8) |
| Steel Round or Oval Pipe | 10 | 40 | 21 | (10) |
| Wood Square or Rectangular | 1 | 12 | 11 | (8) |
| Multiple Post Signs | | | | |
| State Agencies | | | | |
| Steel "U" Single | 4 | 5 | 5 | (6) |
| Steel Square or Rectangular Tube | 1 | 10 | 6 | (2) |
| Steel Round or Oval Pipe | 5 | 10 | 10 | (3) |
| Wood Square or Rectangular | 1 | 5 | 5 | (14) |
| Other Agencies | | | | |
| Steel "U" Single | 5 | 32 | 10 | (7) |
| Steel Square or Rectangular Tube | 5 | 25 | 15 | (2) |
| Steel Round or Oval Pipe | a | a | 20 | (1) |
| Wood Square or Rectangular | 1 | 1 | 1 | (2) |

[a]Insufficient data.

Table C-115.

Types of Special Equipment Needed for the Most Widely Used Sign Systems, by Type of Sign and Type of Post

| Type of Sign/Post Material and Shape | Crane | Basket, Derrick, or Digger | Lift Truck, Sign Truck, or Beam Truck | Post Straightener | Welder or Torch[a] | Other Equipment[b] | Need None | No Response | Total Systems |
|---|---|---|---|---|---|---|---|---|---|
| | Number of Sign Systems | | | | | | | | |
| Single Post Signs | | | | | | | | | |
| Steel "U" Single | 0 | 0 | 3 | 1 | 1 | 4 | 3 | 75 | (87) |
| Steel Tube | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 32 | (35) |
| Steel PIpe | 0 | 0 | 0 | 3 | 1 | 0 | 2 | 33 | (39) |
| Aluminum Pipe | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 9 | (11) |
| Wood (all) | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 53 | (54) |
| Multiple Post Signs | | | | | | | | | |
| Steel "U" Single | 0 | 0 | 2 | 1 | 1 | 1 | 1 | 36 | (42) |
| Steel Beam | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 23 | (27) |
| Steel Pipe | 0 | 0 | 2 | 1 | 0 | 0 | 1 | 9 | (13) |
| Aluminum Pipe | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 9 | (12) |
| Wood (all) | 1 | 0 | 2 | 0 | 0 | 0 | 5 | 50 | (58) |

[a]Oxygen and acetylene

[b]Includes pole driver, tractor with augar, ladder truck, jack hammer and compressor, rivet gun, and/or branding tool.

(4) estimated percentage of maintenance cost due to vandalism, wind-caused failures, and other causes; and (5) maintenance attributes or problems.

Total Maintenance Cost

The respondents were instructed to include all costs (labor, materials, and equipment) attributable to normal maintenance activities in their total annual maintenance cost figures. Unfortunately, the respondents furnished such information on less than one-half of their most widely used sign systems.

Tables C-116 and C-117 show the total maintenance costs of their single and multiple post systems by type of support post. As would be expected, maintenance costs of multiple post systems are greater than maintenance costs of single post systems. The results also show that maintenance costs are considerably higher than maintenance costs of systems with other types of posts.

Table C-117 shows that state agencies pay out more maintenance dollars per sign than do other agencies. Table C-118 shows that maintenance costs vary from region to region as indicated by the maintenance costs of sign systems using steel "U" single posts.

Percentage of Maintenance Cost Due to Labor

As one might suspect, labor makes up a significant percentage of the total maintenance cost of a sign system. Table C-119 shows these percentages for the most widely used sign systems by type of sign and type of post. Considerable variation is seen, with that for type of support post being greatest. Although the percentages vary from 2 to 90 percent, most of them are near 40 percent.

Table C-116.

Total Maintenance Cost of the Most Widely Used Single Post Signs, by Type of Sign and Type of Post

| Type of Sign/Post Material and Shape | Total Maintenance Cost: Percentile Value 25th | Total Maintenance Cost: Percentile Value 75th | Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - - - $/Sign/Year- - - - | | | (Number) |
| Single Post Signs | | | | |
| Steel | | | | |
| "U" Single | 2 | 15 | 5 | (32) |
| "U" Back to Back | a | a | 1 | (1) |
| Square or Rectangular Tube | 4 | 14 | 10 | (13) |
| Round or Oval Pipe | 2 | 11 | 7 | (19) |
| Beam (I, S, W, H) | 12 | 12 | 12 | (2) |
| Aluminum | | | | |
| Square or Rectangular Tube | a | a | 5 | (1) |
| Round or Oval Pipe | 10 | 229 | 15 | (3) |
| Wood | | | | |
| Square or Rectangular | 5 | 24 | 10 | (23) |
| Round | 4 | 5 | 4 | (3) |
| Multiple Post Signs | | | | |
| Steel | | | | |
| "U" Single | 6 | 17 | 9 | (13) |
| "U" Back to Back | 2 | 19 | 11 | (2) |
| Square or Rectangular Tube | 4 | 26 | 13 | (7) |
| Round or Oval Pipe | 3 | 15 | 11 | (6) |
| Beam (I, S, W, H) | 22 | 42 | 31 | (11) |
| Aluminum | | | | |
| Square or Rectangular Tube | a | a | 1 | (1) |
| Round or Oval Pipe | 24 | 534 | 36 | (3) |
| Wood | | | | |
| Square or Rectangular | 8 | 15 | 11 | (23) |
| Round | 7 | 9 | 7 | (3) |

[a]Insufficient data

Table C-117.

Total Maintenance Cost of the Most Widely Used Sign Systems, by Type of Sign, Type of Post, and Type of Respondent

| Type of Sign/Post Respondent | Total Maintenance Cost | | | Total Systems |
|---|---|---|---|---|
| | Percentile Value 25th | Percentile Value 75th | Median Value | |
| | - - - - - $/Sign- - - - - - | | | (Number) |
| Single Post Signs | | | | |
| State Agencies | | | | |
| Steel "U" Single | 3 | 15 | 7 | (14) |
| Steel Square or Rectangular Tube | 10 | 14 | 12 | (8) |
| Steel Round or Oval Pipe | 7 | 16 | 10 | (10) |
| Wood Square or Rectangular | 7 | 19 | 11 | (15) |
| Other Agencies | | | | |
| Steel "U" Single | 2 | 15 | 3 | (18) |
| Steel Square or Rectangular Tube | 3 | 9 | 4 | (5) |
| Steel Round or Oval Pipe | 1 | 4 | 2 | (9) |
| Wood Square or Rectangular | 4 | 36 | 5 | (8) |
| Multiple Post Signs | | | | |
| State Agencies | | | | |
| Steel "U" Single | 1 | 15 | 12 | (6) |
| Steel Square or Rectangular Tube | 16 | 39 | 24 | (4) |
| Steel Round or Oval Pipe | 11 | 15 | 15 | (4) |
| Wood Square or Rectangular | 10 | 30 | 13 | (17) |
| Other Agencies | | | | |
| Steel "U" Single | 7 | 18 | 8 | (7) |
| Steel Square or Rectangular Tube | 3 | 5 | 4 | (3) |
| Steel Round or Oval Pipe | 1 | 3 | 2 | (2) |
| Wood Square or Rectangular | 8 | 10 | 10 | (6) |

Table C-118.

Total Cost to Maintain Single Post Sign Systems with Steel "U" Single Posts, by Region

| Region | Total Maintenance Cost | | | Total Systems |
|---|---|---|---|---|
| | Percentile Value | | Median Value | |
| | 25th | 75th | | |
| | - - - - - $/Sign- - - - - - | | | (Number) |
| 1&2 | 5 | 18 | 5 | (10) |
| 3 | 2 | 3 | 2 | (2) |
| 4 | 1 | 6 | 4 | (3) |
| 5 | 1 | 23 | 3 | (7) |
| 6 | 3 | 12 | 7 | (2) |
| 7 | 1 | 17 | 2 | (5) |
| 8 | 1 | 3 | 2 | (2) |
| 9 | a | a | 9 | (1) |
| 10 | a | a | a | (0) |

[a]Insufficient data.

Table C-119.

Percentage of Total Maintenance Cost Due to Labor for the Most Widely Used Sign Systems, by Type of Sign and Type of Post

| Type of Sign/Post Material and Shape | Percentage of Total Cost | | | |
|---|---|---|---|---|
| | Percentile Value | | Median Value | Total Systems |
| | 25th | 75th | | |
| | - - - - - Percent | | - - - - - | (Number) |
| Single Post Signs | | | | |
| Steel | | | | |
| "U" Single | 19 | 60 | 38 | (35) |
| "U" Back to Back | a | a | 2 | (1) |
| Square or Rectangular Tube | 25 | 67 | 43 | (12) |
| Round or Oval Pipe | 33 | 50 | 45 | (18) |
| Beam (I,S,W, or H) | a | a | 36 | (1) |
| Aluminum | | | | |
| Round or Oval Pipe | 14 | 55 | 20 | (3) |
| Wood | | | | |
| Square or Rectangular | 30 | 59 | 45 | (23) |
| Round | 51 | 78 | 70 | (3) |
| Multiple Post Signs | | | | |
| Steel | | | | |
| "U" Single | 18 | 40 | 30 | (15) |
| "U" Back to Back | 10 | 74 | 42 | (2) |
| Square or Rectangular Tube | 27 | 69 | 45 | (7) |
| Round or Oval Pipe | 30 | 50 | 50 | (6) |
| Beam (I,S,W, or H) | 30 | 76 | 45 | (11) |
| Aluminum | | | | |
| Round or Oval Pipe | 14 | 20 | 20 | (3) |
| Wood | | | | |
| Square or Rectangular | 31 | 74 | 50 | (23) |
| Round | 50 | 90 | 90 | (3) |

[a]Insufficient data.

Table C-120 shows that in most cases the state agency percentages of total maintenance cost due to labor are higher (almost twice as high in some cases) than the other agency percentages for sign systems with the same type of support post. The reasons for these differences are not known.

## Total Labor Used

Estimates of the total man-hours of labor used for maintenance of the most widely used sign systems are shown in Table C-121 by type of sign and type of post. Again, there is considerable variation in the amount of labor used by type of sign and type of support post used. The amount of labor used to maintain single post systems is usually less than that used to maintain multiple post systems. More labor is required to maintain sign systems with steel beam posts and wood posts than systems with other types of posts.

The total labor used for maintenance of various sign systems varies by type of respondent (Table C-122). There is no consistent pattern in this variation.

Table C-123 shows that the total labor used to maintain single post signs with steel "U" single posts varies considerably by region. The amount of labor used by respondents in Regions 1 and 2 is especially high compared to that used by respondents in the other regions. The reason for such a great difference in labor use is not known.

## Unit Labor Cost

Unit labor costs to maintain the most widely used sign systems by type of respondent and by region are given in Table C-124. These unit

Table C-120.

Percentage of Total Maintenance Cost Due to Labor for the Most Widely Used Sign Systems, by Type of Sign, Type of Post, and Type of Respondent

| Type of Sign/Post Respondent | Percentage of Total Cost: Percentile Value 25th | Percentile Value 75th | Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - - Percent | - - - - - | | (Number |
| Single Post Signs | | | | |
| State Agencies | | | | |
| Steel "U" Single | 20 | 54 | 40 | (17) |
| Steel Square or Rectangular Tube | 31 | 74 | 53 | (8) |
| Steel Round or Oval Pipe | 39 | 63 | 50 | (11) |
| Wood Square or Rectangular | 30 | 72 | 50 | (15) |
| Other Agencies | | | | |
| Steel "U" Single | 18 | 63 | 22 | (18) |
| Steel Square or Rectangular Tube | 13 | 50 | 29 | (4) |
| Steel Round or Oval Pipe | 9 | 50 | 35 | (7) |
| Wood Square or Rectangular | 35 | 46 | 40 | (8) |
| Multiple Post Signs | | | | |
| State Agencies | | | | |
| Steel "U" Single | 17 | 40 | 34 | (9) |
| Steel Square or Rectangular Tube | 28 | 83 | 60 | (4) |
| Steel Round or Oval Pipe | 50 | 50 | 50 | (4) |
| Wood Square or Rectangular | 30 | 70 | 50 | (17) |
| Other Agencies | | | | |
| Steel "U" Single | 18 | 37 | 24 | (6) |
| Steel Square or Rectangular Tube | 27 | 46 | 33 | (3) |
| Steel Round or Oval Pipe | 1 | 30 | 15 | (2) |
| Wood Square or Rectangular | 35 | 90 | 63 | (6) |

Table C-121.

Total Labor Used for Maintenance of the Most Widely Used Sign Systems, by Type of Sign and Type of Post

| Type of Sign/Post Material and Shape | Total Labor | | | |
|---|---|---|---|---|
| | Percentile Value | | Median Value | Total Systems |
| | 25th | 75th | | |
| | - - - -Man-Hrs/Sign - - - - | | | (Number) |
| Single Post Signs | | | | |
| Steel | | | | |
| "U" Single | 0.2 | 1.3 | 0.4 | (30) |
| "U" Back to Back | a | a | 0.1 | (1) |
| Square or Rectangular Tube | 0.4 | 1.3 | 0.9 | (13) |
| Round or Oval Pipe | 0.2 | 1.0 | 0.8 | (18) |
| Beam (I,S,W, or H) | a | a | 0.7 | (1) |
| Aluminum | | | | |
| Square or Rectangular Tube | a | a | 0.1 | (1) |
| Round or Oval Pipe | 0.4 | 6.1 | 0.5 | (3) |
| Wood | | | | |
| Square or Rectangular | 0.3 | 1.0 | 1.0 | (22) |
| Round | 0.3 | 0.5 | 0.5 | (3) |
| Multiple Post Signs | | | | |
| Steel | | | | |
| "U" Single | 0.3 | 1.3 | 0.7 | (12) |
| "U" Back to Back | 0.2 | 5.0 | 2.6 | (2) |
| Square or Rectangular Tube | 0.5 | 1.8 | 1.0 | (7) |
| Round or Oval Pipe | 0.8 | 1.5 | 1.5 | (5) |
| Beam (I,S,W, or H) | 1.5 | 4.0 | 2.0 | (10) |
| Aluminum | | | | |
| Square or Rectangular Tube | a | a | 0.1 | (1) |
| Round or Oval Pipe | 0.4 | 12.1 | 0.4 | (3) |
| Wood | | | | |
| Square or Rectangular | 0.8 | 2.0 | 1.0 | (22) |
| Round | 0.6 | 1.0 | 1.0 | (3) |

[a]Insufficient data.

Table C-122.

Total Labor Used for Maintenance of the Most Widely Used Sign Systems, by Type of Sign, Type of Post, and Type of Respondent

| Type of Sign/Post Respondent | Total Labor: Percentile Value 25th | Total Labor: Percentile Value 75th | Total Labor: Median Value | Total Systems |
|---|---|---|---|---|
| | - - - Man-Hours/Sign - - - | | | (Number) |
| **Single Post Signs** | | | | |
| State Agencies | | | | |
| Steel "U" Single | 0.3 | 1.6 | 0.4 | (13) |
| Steel Square or Rectangular Tube | 0.6 | 1.5 | 0.8 | (8) |
| Steel Round or Oval Pipe | 0.8 | 1.5 | 1.0 | (10) |
| Wood Square or Rectangular | 0.8 | 2.0 | 1.0 | (14) |
| Other Agencies | | | | |
| Steel "U" Single | 0.2 | 1.1 | 0.5 | (17) |
| Steel Square or Rectangular Tube | 0.2 | 3.7 | 0.9 | (5) |
| Steel Round or Oval Pipe | 0.1 | 0.6 | 0.2 | (8) |
| Wood Square or Rectangular | 0.2 | 1.0 | 0.4 | (8) |
| **Multiple Post Signs** | | | | |
| State Agencies | | | | |
| Steel "U" Single | 0.3 | 1.3 | 0.4 | (6) |
| Steel Square or Rectangular Tube | 0.7 | 3.0 | 1.5 | (4) |
| Wood Square or Rectangular | 0.8 | 2.5 | 1.0 | (16) |
| Other Agencies | | | | |
| Steel "U" Single | 0.3 | 2.0 | 1.2 | (6) |
| Steel Square or Rectangular Tube | 0.4 | 1.0 | 1.0 | (3) |
| Wood Square or Rectangular | 0.3 | 1.0 | 0.8 | (6) |

Table C-123.

Total Labor Used to Maintain Single Post Signs with Steel "U" Single Posts, by Region

| Region | Total Labor | | | |
|---|---|---|---|---|
| | Percentile Value | | Median Value | Total Systems |
| | 25th | 75th | | |
| | - - - -Man-Hrs/Sign - - - - | | | (Number) |
| 1&2 | 0.4 | 3.3 | 2.0 | (9) |
| 3 | 0.1 | 1.0 | 0.5 | (2) |
| 4 | 0.1 | 0.3 | 0.3 | (3) |
| 5 | 0.1 | 1.0 | 0.3 | (6) |
| 6 | 0.2 | 0.5 | 0.3 | (2) |
| 7 | 0.4 | 2.0 | 0.7 | (5) |
| 8 | 0.2 | 0.3 | 0.2 | (2) |
| 9 | 0.3 | 0.3 | 0.3 | (1) |
| 10 | a | a | a | (0) |

[a] Insufficient data.

Table C-124.

Unit Labor Cost of Maintenance of the Most Widely Used Sign Systems, by Type of Respondent and Region[a]

| Type of Respondent/ Region | Unit Labor Cost[b] Percentile Value 25th | 75th | Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - - $/Man-Hour | | - - - - - | (Number) |
| Type of Respondent | | | | |
| State Agencies | 3.98 | 6.69 | 4.75 | (97) |
| Other | 1.01 | 7.64 | 5.88 | (55) |
| All | 3.28 | 7.54 | 4.95 | (152) |
| Region | | | | |
| 1&2 | 1.25 | 5.89 | 4.50 | (28) |
| 3 | 1.75 | 7.98 | 2.00 | (5) |
| 4 | 4.35 | 12.60 | 10.32 | (10) |
| 5 | 2.36 | 7.00 | 6.59 | (24) |
| 6 | 0.28 | 7.58 | 4.42 | (22) |
| 7 | 3.19 | 4.01 | 3.65 | (12) |
| 8 | 3.28 | 6.91 | 6.30 | (16) |
| 9 | 4.85 | 6.75 | 6.26 | (12) |
| 10 | 4.38 | 18.08 | 8.00 | (23) |

[a]Includes both single and multiple post systems.

[b]Based on total labor maintenance cost and total labor for sign maintenance.

costs are based on single and multiple post systems combined. As can be seen, state agencies have somewhat lower unit labor costs than do other agencies. On the other hand, there is considerable variation on a regional basis. In fact, the unit labor costs for maintenance vary from $2.00 to $10.32 per man-hour. The extreme values occur in adjacent Regions 3 and 4.

By referring back to Table C-104, one can see that the unit labor costs for sign system maintenance are somewhat lower than the unit costs for sign system repair. Also, by comparing Tables C-67, C-104, and C-124, it is evident that unit labor costs of sign system installation are generally higher than the unit labor costs for either sign system repair or maintenance.

Percentage of Maintenance Cost Due to Vandalism

To get some idea of how much of the maintenance costs is due to various things, the respondents were asked to estimate the percentage of sign system maintenance cost due to vandalism, wind-caused failures, and other causes. Table C-125 shows the maintenance cost percentages due to vandalism by type of sign and type of post. There is considerable variation with percentages from 5 to 85 percent. However, most of the percentages are near 30 percent.

Table C-126 shows the maintenance cost percentages due to vandalism by type of respondent. State agencies have lower percentages than the other agencies. Perhaps one reason is because more of the sign systems of the other agencies are located in or near urban areas than is the case of state agencies.

Table C-125.

Percentage of Sign Maintenance Cost Due to Vandalism, by Type of Sign and Type of Post

| Type of Sign/Post Material and Shape | Percentage of Maintenance Cost: Percentile Value 25th | Percentile Value 75th | Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - - Percent | - - - - - | | (Number) |
| Single Post Signs | | | | |
| Steel | | | | |
| "U" Single | 10 | 75 | 40 | (41) |
| "U" Back to Back | a | a | 20 | (1) |
| Square or Rectangular Tube | 13 | 71 | 23 | (11) |
| Round or Oval Pipe | 15 | 80 | 30 | (23) |
| Beam (I,S,W, or H) | 23 | 40 | 32 | (2) |
| Aluminum | | | | |
| Square or Rectangular Tube | a | a | 50 | (1) |
| Round or Oval Pipe | 15 | 71 | 30 | (3) |
| Wood | | | | |
| Square or Rectangular | 20 | 70 | 40 | (28) |
| Round | 16 | 58 | 50 | (3) |
| Multiple Post Signs | | | | |
| Steel | | | | |
| "U" Single | 22 | 50 | 30 | (17) |
| "U" Back to Back | 75 | 95 | 85 | (2) |
| Square or Rectangular Tube | 10 | 75 | 22 | (6) |
| Round or Oval Pipe | 10 | 60 | 13 | (6) |
| Beam (I,S,W, or H) | 10 | 48 | 15 | (13) |
| Aluminum | | | | |
| Square or Rectangular Tube | a | a | 10 | (1) |
| Round or Oval Pipe | 10 | 25 | 10 | (3) |
| Wood | | | | |
| Square or Rectangular | 20 | 70 | 30 | (25) |
| Round | 5 | 39 | 5 | (3) |

[a] Insufficient data.

Table C-126.

Percentage of Sign Maintenance Cost Due to Vandalism, by Type of Sign, Type of Post, and Type of Respondent

| Type of Sign/Post Respondent | Percentage of Maintenance Cost | | | |
|---|---|---|---|---|
| | Percentile Value | | Median Value | Total Systems |
| | 25th | 75th | | |
| | - - - - - Percent | | - - - - - | (Number) |
| Single Post Signs | | | | |
| State Agencies | | | | |
| Steel "U" Single | 10 | 45 | 25 | (20) |
| Steel Square or Rectangular Tube | 21 | 71 | 40 | (7) |
| Steel Round or Oval Pipe | 10 | 35 | 15 | (11) |
| Wood Square or Rectangular | 20 | 51 | 40 | (17) |
| Other Agencies | | | | |
| Steel "U" Single | 15 | 85 | 50 | (21) |
| Steel Square or Rectangular Tube | 3 | 58 | 13 | (4) |
| Steel Round or Oval Pipe | 25 | 83 | 78 | (12) |
| Wood Square or Rectangular | 21 | 70 | 60 | (11) |
| Multiple Post Signs | | | | |
| State Agencies | | | | |
| Steel "U" Single | 23 | 45 | 28 | (10) |
| Steel Square or Rectangular Tube | 15 | 49 | 22 | (4) |
| Steel Round or Oval Pipe | 9 | 60 | 38 | (4) |
| Wood Square or Rectangular | 20 | 43 | 30 | (17) |
| Other Agencies | | | | |
| Steel "U" Single | 21 | 91 | 50 | (7) |
| Steel Square or Rectangular Tube | 5 | 85 | 45 | (2) |
| Steel Round or Oval Pipe | 10 | 10 | 10 | (2) |
| Wood Square or Rectangular | 18 | 80 | 65 | (8) |

## Percentage of Maintenance Cost Due to Wind

Maintenance cost percentages for wind caused failures by type of sign and type of post are presented in Table C-127. With a few exceptions, the percentages of maintenance cost due to wind are very low. There is considerable variation by type of support post, but there is little variation by type of sign.

Table C-128 shows the maintenance cost percentages for wind caused failures by type of respondent. There is considerable variation in the percentages, but there is no definite pattern showing state agency percentages to be consistently lower or higher than the other agency percentage.

## Percentage of Maintenance Cost Due to Other Causes

Finally, Table C-129 shows the percentages of maintenance cost due to other causes by type of sign and type of post. As is evident, these percentages are much higher than those attributable to vandalism or wind. Again, there is considerable variation in the percentages by type of sign and also by type of post.

Table C-130 gives these percentages by type of respondent. Except for the sign systems with steel tube posts, the state agency percentages are higher than the other agency percentages.

Table C-129.

Percentage of Sign Maintenance Cost Due to Other Causes, by Type of Sign and Type of Post

| Type of Sign/Post Material and Shape | Percentage of Maintenance Cost: Percentile Value 25th | Percentile Value 75th | Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - - Percent | | - - - - - | (Number) |
| Single Post Signs | | | | |
| Steel | | | | |
| "U" Single | 15 | 74 | 50 | (39) |
| "U" Back to Back | a | a | 40 | (1) |
| Square or Rectangular Tube | 8 | 68 | 25 | (11) |
| Round or Oval Pipe | 15 | 80 | 62 | (22) |
| Beam (I,S,W, or H) | 59 | 69 | 64 | (2) |
| Aluminum | | | | |
| Square or Rectangular Tube | a | a | 50 | (1) |
| Round or Oval Pipe | 16 | 43 | 20 | (3) |
| Wood | | | | |
| Square or Rectangular | 25 | 67 | 50 | (26) |
| Round | 41 | 82 | 45 | (3) |
| Multiple Post Signs | | | | |
| Steel | | | | |
| "U" Single | 20 | 70 | 57 | (16) |
| "U" Back to Back | 2 | 5 | 3 | (2) |
| Square or Rectangular Tube | 15 | 80 | 45 | (6) |
| Round or Oval Pipe | 35 | 90 | 76 | (6) |
| Beam (I,S,W, or H) | 51 | 88 | 80 | (13) |
| Aluminum | | | | |
| Square or Rectangular Tube | a | a | 90 | (1) |
| Round or Oval Pipe | 20 | 43 | 20 | (3) |
| Wood | | | | |
| Square or Rectangular | 20 | 79 | 60 | (25) |
| Round | 61 | 94 | 94 | (3) |

[a]Insufficient data.

Table C-130.

Percentage of Sign Maintenance Cost Due to Other Causes by Type of Sign, Type of Post, and Type of Respondent

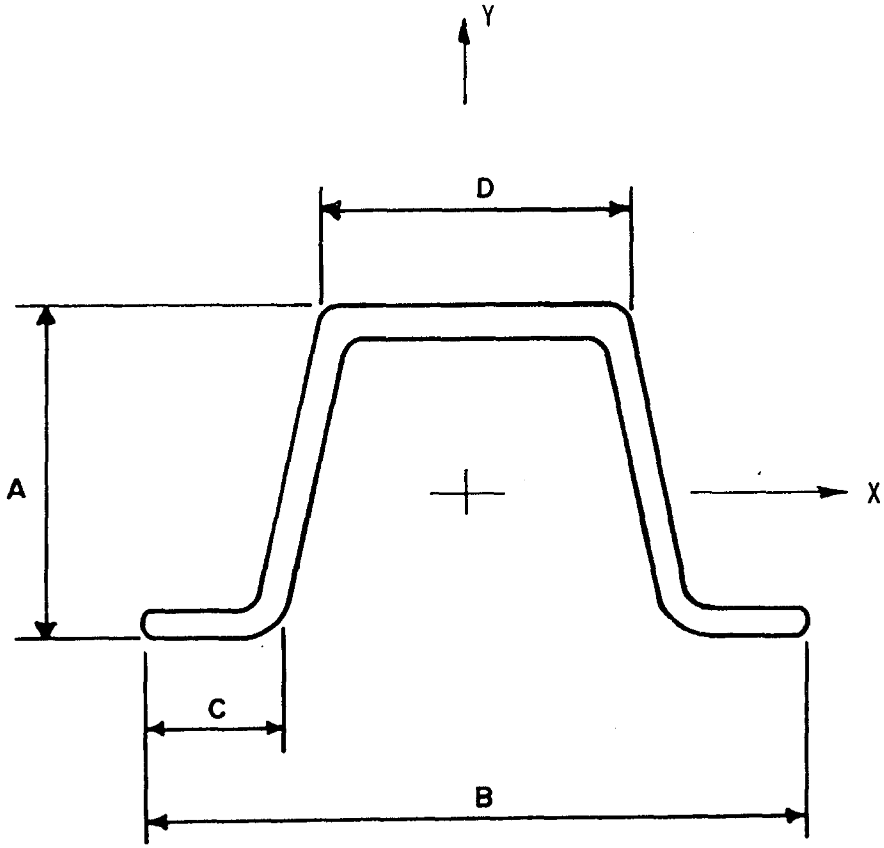
| Type of Sign/Post Respondent | Percentage of Maintenance Cost: Percentile Value 25th | Percentile Value 75th | Median Value | Total Systems |
|---|---|---|---|---|
| | - - - - - Percent | - - - - - | | (Number) |
| Single Post Signs | | | | |
| State Agencies | | | | |
| Steel "U" Single | 20 | 78 | 58 | (20) |
| Steel Square or Rectangular Tube | 16 | 66 | 25 | (7) |
| Steel Round or Oval Pipe | 60 | 84 | 80 | (11) |
| Wood Square or Rectangular | 18 | 67 | 54 | (16) |
| Other Agencies | | | | |
| Steel "U" Single | 6 | 74 | 20 | (19) |
| Steel Square or Rectangular Tube | 2 | 80 | 34 | (4) |
| Steel Round or Oval Pipe | 10 | 61 | 15 | (11) |
| Wood Square or Rectangular | 25 | 75 | 43 | (10) |
| Multiple Post Signs | | | | |
| State Agencies | | | | |
| Steel "U" Single | 25 | 70 | 65 | (10) |
| Steel Square or Rectangular Tube | 13 | 75 | 45 | (4) |
| Steel Round or Oval Pipe | 35 | 76 | 51 | (4) |
| Wood Square or Rectangular | 24 | 73 | 60 | (17) |
| Other Agencies | | | | |
| Steel "U" Single | 5 | 55 | 30 | (6) |
| Steel Square or Rectangular Tube | 15 | 94 | 55 | (2) |
| Steel Round or Oval Pipe | 90 | 90 | 90 | (2) |
| Wood Square or Rectangular | 19 | 79 | 35 | (8) |

# APPENDIX D

## U-POST DETAILS

Since the U-post is a widely used support for small signs and since several types of U-posts are marketed, this Appendix was prepared to illustrate the design variations available. Although the types included herein are believed to be representative of most U-posts now being used, there are other types and suppliers of the post.

NOTE: Cross-sectional properties of the U-posts shown herein were supplied by the respective suppliers.



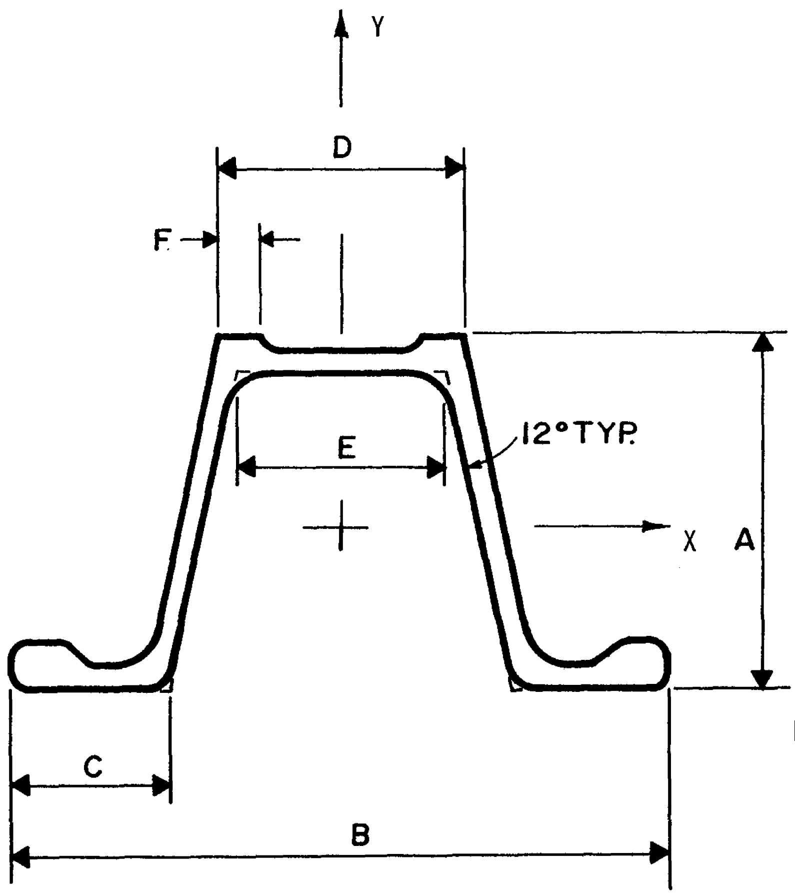

| SIGN POST | A (in) | B (in) | C (in) | D (in) | $I_{xx}$ ($in^4$) | $S_x$ ($in^3$) | $I_{yy}$ ($in^4$) | $S_y$ ($in^3$) |
|---|---|---|---|---|---|---|---|---|
| 2.0 lb/ft | 1.516 | 3.125 | .625 | 1.25 | .179 | .225 | .442 | .283 |
| 2.25 lb/ft | 1.532 | 3.125 | .625 | 1.25 | .201 | .254 | .474 | .303 |
| 2.5 lb/ft | 1.562 | 3.125 | .625 | 1.25 | .233 | .289 | .551 | .353 |
| 2.75 lb/ft | 1.578 | 3.125 | .625 | 1.25 | .271 | .329 | .607 | .389 |
| 3.0 lb/ft | 1.750 | 3.50 | .719 | 1.625 | .372 | .403 | .870 | .497 |
| 4.0 lb/ft | 1.750 | 3.50 | .797 | 1.625 | .460 | .511 | 1.090 | .623 |

REMARKS: MANUFACTURED BY FRANKLIN STEEL COMPANY

NOTE: These designs can be bolted together back-to-back to form larger sections.

METRIC CONVERSION: 1 inch = 0.0254 m
1 lb = 4.45N

Figure D-1. Franklin Steel U-Post Designs (5)

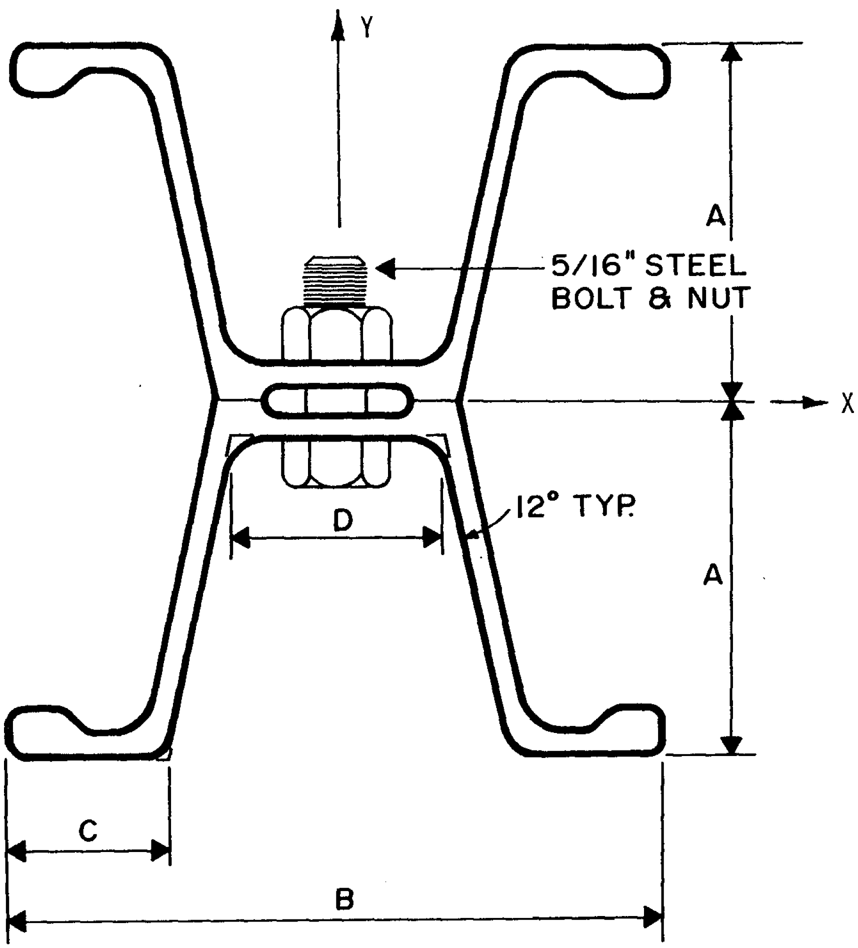



| SIGN POST | A | B | C | D | E | F | $I_{xx}$ | $S_x$ | $I_{yy}$ | $S_y$ |
|---|---|---|---|---|---|---|---|---|---|---|
| **2.00** lbs/ft | 1.375 in. | 3.077 in. | .741 in. | 1.188 in. | 1.047 in. | .188 in. | .153 $in.^4$ | .205 $in.^3$ | .415 $in.^4$ | .270 $in.^3$ |
| **3.00** lbs/ft | 1.891 in. | 3.543 in. | .828 in. | 1.339 in. | 1.156 in. | .219 in. | .430 $in.^4$ | .409 $in.^3$ | .920 $in.^4$ | .519 $in.^3$ |

**REMARKS: MANUFACTURED BY ARMCO STEEL CORP.**

METRIC CONVERSIONS: 1 inch = 0.0254 m
1 lb = 4.45 N
1 lb/ft = 1.487 kg/m

Figure D-2. Armco Steel U-Post (6)




| SIGN POST | A | B | C | D | $I_{xx}$ | $S_x$ | $I_{yy}$ | $S_y$ |
|---|---|---|---|---|---|---|---|---|
| 4.00 * 4.00 lb/ft | 1.375 in. | 3.077 in. | .741 in. | 1.047 in. | .960 in.$^4$ | .698 in.$^3$ | .830 in.$^4$ | .540 in.$^3$ |
| 6.00 ** 6.00 lb/ft | 1.891 in. | 3.543 in. | .828 in. | 1.156 in. | 2.874 in.$^4$ | 1.520 in.$^3$ | 1.840 in.$^4$ | 1.038 in.$^3$ |

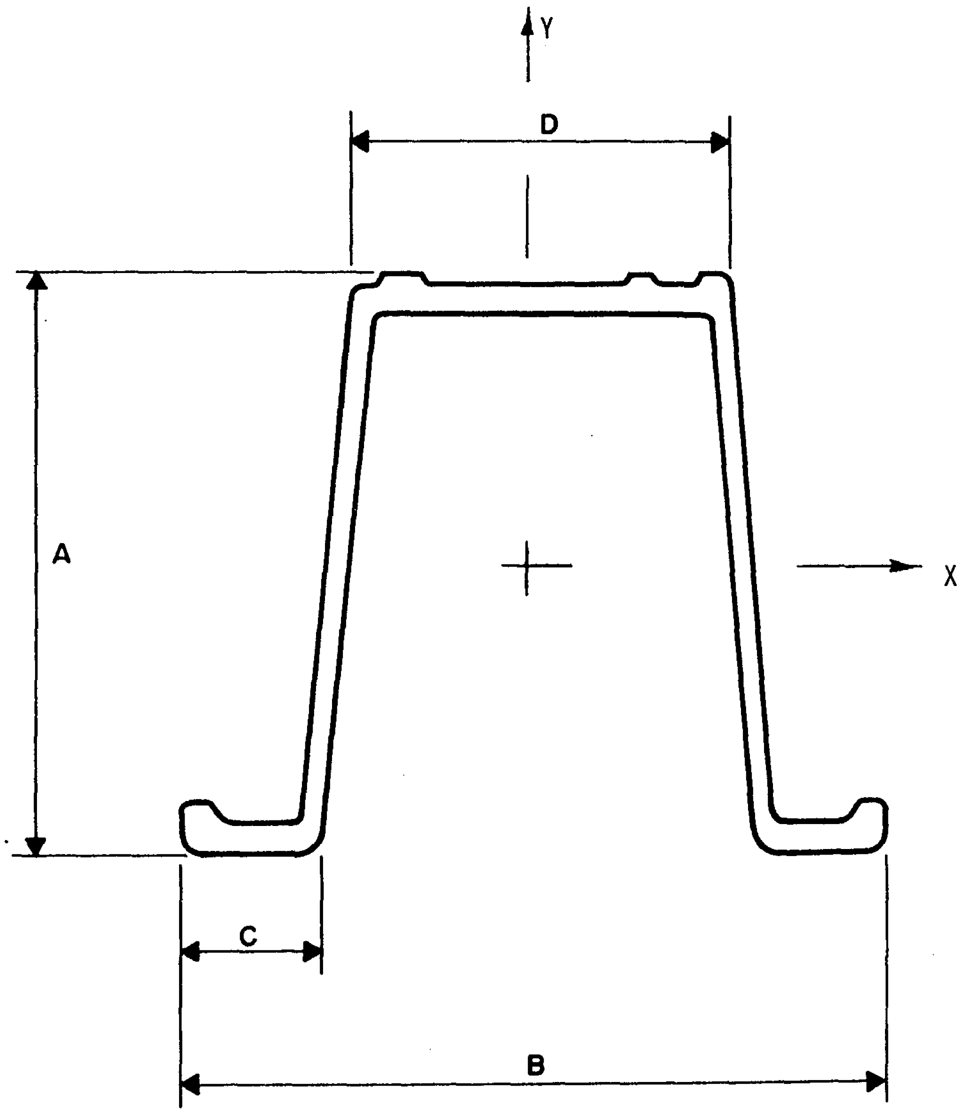
REMARKS: MANUFACTURED BY ARMCO STEEL CORP.

*Two 2 lb/ft back-to-back

**Two 3 lb/ft back-to-back

METRIC CONVERSIONS: 1 inch = 0.0254 m
1 lb = 4.45 N
1 lb/ft = 1.487 kg/m

Figure D-3. Armco Steel U-Post, Back-to-Back Design (6)



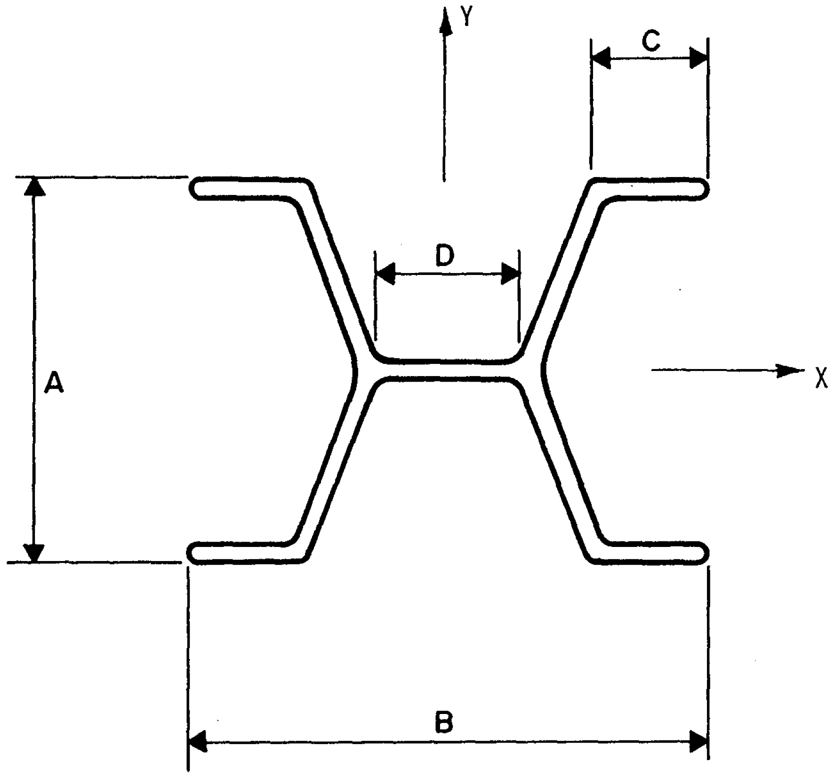

| SIGN POST | A | B | C | D | $I_{xx}$ | $S_x$ | $I_{yy}$ | $S_y$ |
|---|---|---|---|---|---|---|---|---|
| # 2.5 * | 2.437 in. | 3.5 in. | .75 in. | 1.75 in. | .734 $in.^4$ | .602 $in.^3$ | .822 $in.^4$ | .504 $in.^3$ |
| # 4* | 3.062 in. | 3.75 in. | .75 in. | 2.00 in. | 1.668 $in.^4$ | 1.149 $in.^3$ | 1.475 $in.^4$ | .787 $in.^3$ |

REMARKS: MANUFACTURED BY MAGNODE PRODUCTS, INC.

*Magnode designation.

METRIC CONVERSION: 1 inch = 0.0254 m

Figure D-4. Magnode Aluminum U-Post (7)



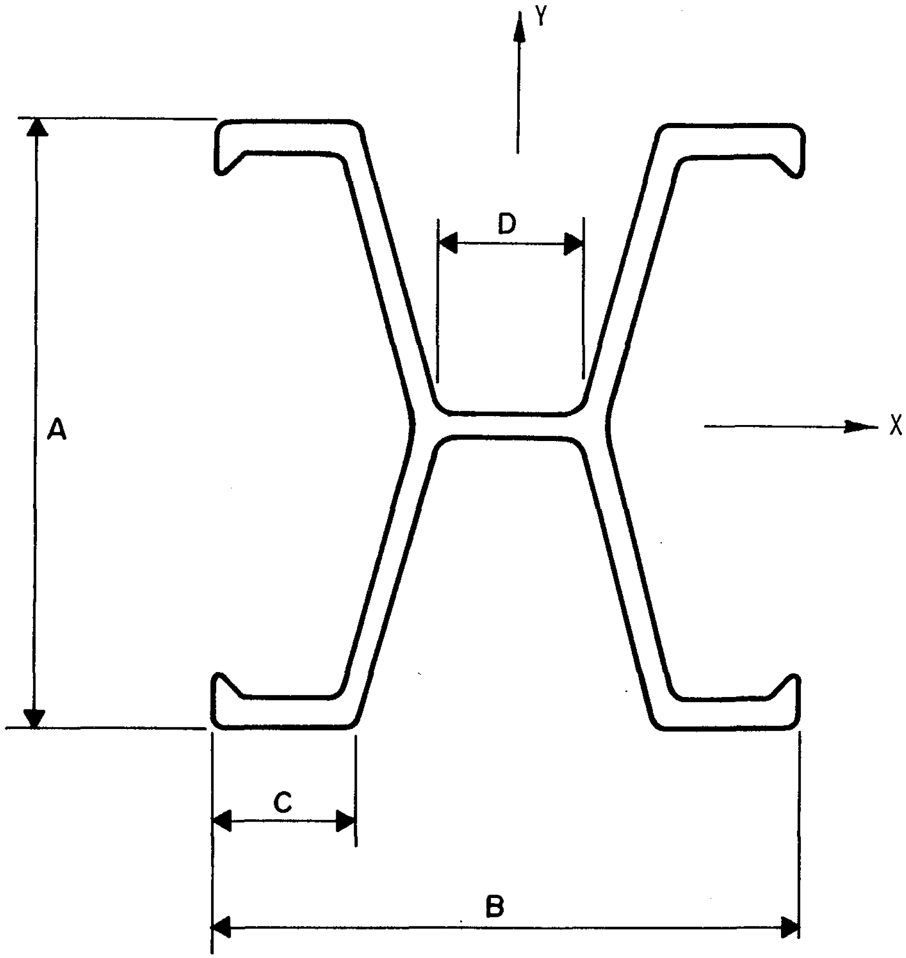

| SIGN POST | A | B | C | D | $I_{xx}$ | $S_x$ | $I_{yy}$ | $S_y$ |
|---|---|---|---|---|---|---|---|---|
| # 2X* | 2.00 in. | 2.75 in. | .625 in. | .75 in. | .342 $in.^4$ | .342 $in.^3$ | .432 $in.^4$ | .314 $in.^3$ |
| – | – | – | – | – | – | – | – | – |

REMARKS: MANUFACTURED BY MAGNODE PRODUCTS, INC.

*Magnode designation.

METRIC CONVERSION: 1 inch = 0.0254 m

Figure D-4. (Continued)



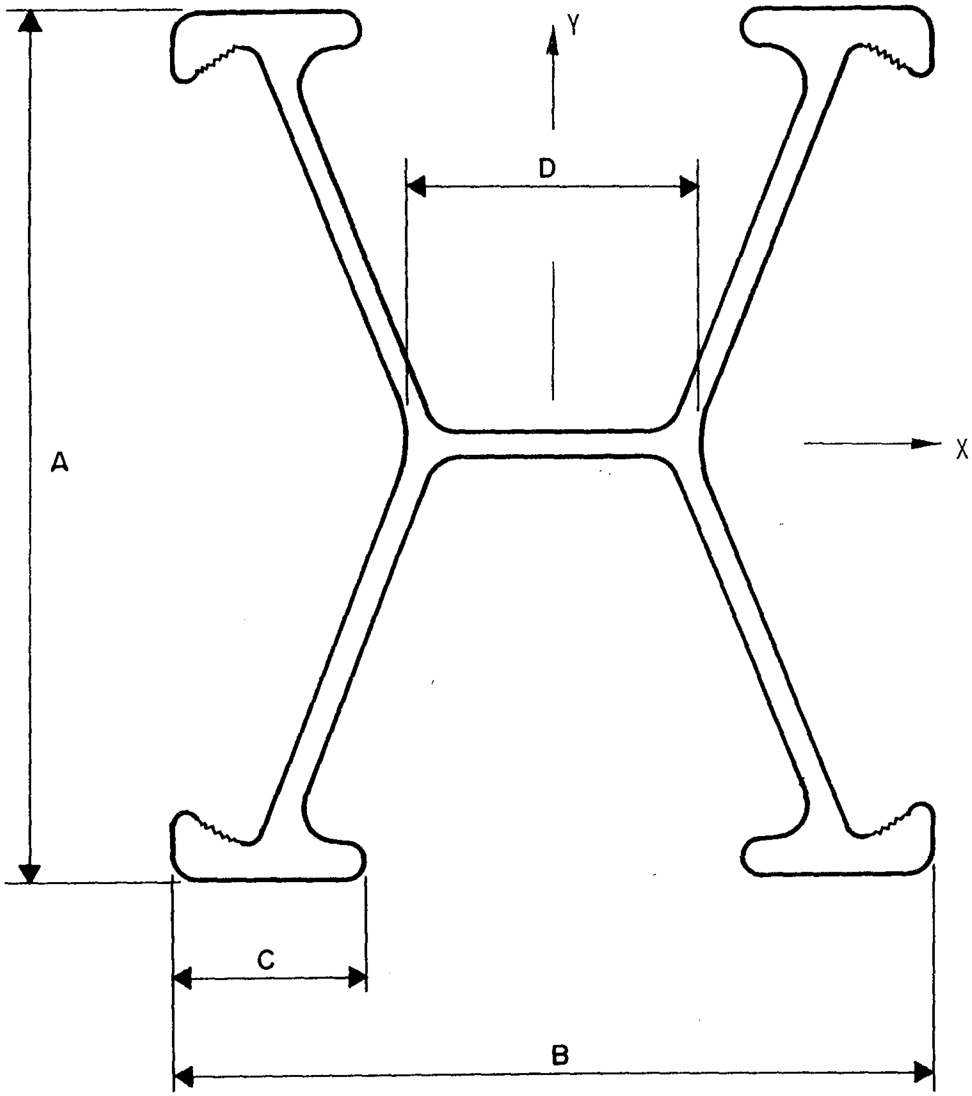

| SIGN POST | A | B | C | D | $I_{xx}$ | $S_x$ | $I_{yy}$ | $S_y$ |
|---|---|---|---|---|---|---|---|---|
| # 3 X * | 3.00 in. | 3.125 in. | .765 in. | .75 in. | 1.041 in.$^4$ | .694 in.$^3$ | .759 in.$^4$ | .468 in.$^3$ |
| # 4 X * | 3.188 in. | 3.125 in. | .765 in. | .75 in. | 1.575 in.$^4$ | .988 in.$^3$ | 1.054 in.$^4$ | .675 in.$^3$ |

REMARKS: MANUFACTURED BY MAGNODE PRODUCTS, INC.

*Magnode designation.

METRIC CONVERSION: 1 inch = 0.0254 m

Figure D-4. (Continued)




| SIGN POST | A | B | C | D | $I_{xx}$ | $S_x$ | $I_{yy}$ | $S_y$ |
|---|---|---|---|---|---|---|---|---|
| # 6X* | 4.50 in. | 4.00 in. | 1.00 in. | 1.563 in. | 5.742 $in.^4$ | 2.552 $in.^3$ | 3.431 $in.^4$ | 1.716 $in.^3$ |
| # 8X* | 5.132 in. | 4.00 in. | 1.00 in. | 1.563 in. | 8.798 $in.^4$ | 3.428 $in.^3$ | 4.369 $in.^4$ | 2.184 $in.^3$ |

REMARKS: MANUFACTURED BY MAGNODE PRODUCTS INC.

*Magnode designation.

METRIC CONVERSION: 1 inch = 0.0254 m

Figure D-4. (Continued)

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