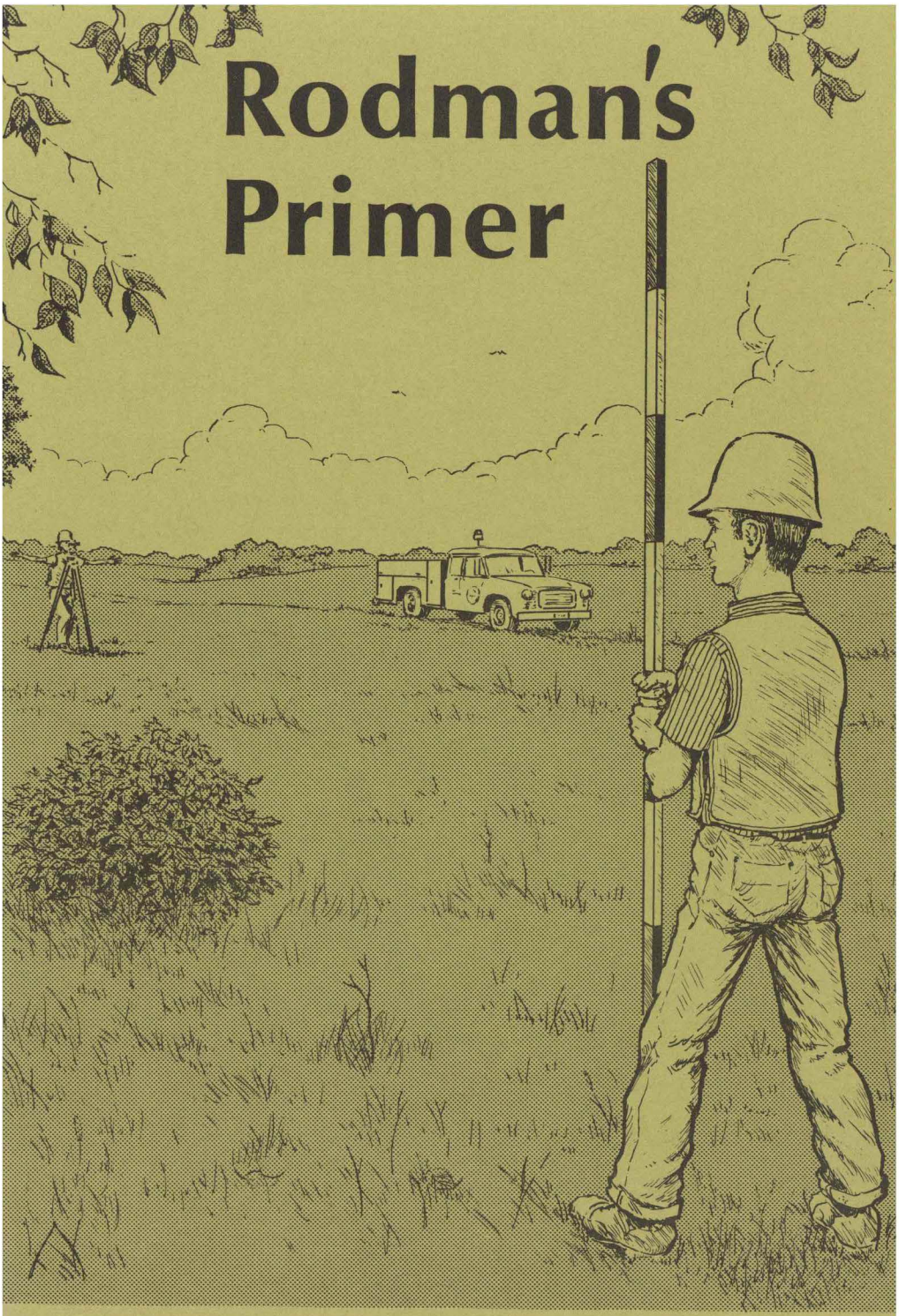
Rodman's Primer



Iowa State Highway Commission

INTRODUCTION

The purpose of this pamphlet is to acquaint a new employee with some of the activities and work of a survey party. A survey party usually consists of four men-instrumentman, notekeeper and two rodmen. The chief of the party generally acts as the notekeeper. The rodmen should be fairly agile, since they perform much of the legwork necessary in the work of surveying.

A new rodman should learn early how to dress for outdoor work in keeping with the season, keeping in mind that sudden changes in the weather are common. At times overshoes or heavy boots may be necessary. A piece of lumberman's chalk (called keel) should always be carried by a rodman. This is used to mark the required information on stakes, turning points, etc.

Since most new rodmen are assigned to construction survey parties, and most of the instructions will also be applicable to preliminary survey work, this pamphlet is being written with the construction rodman's duties in mind.

The survey party on construction reruns survey lines, sets stakes establishing location and grade of structures and pavements, and takes cross sections necessary to measure the materials moved in the construction of a road. To accomplish these things efficiently, the newcomer should know something about the tools used and, since the members of the party are often too far apart to be heard, the signals employed to carry on the work.

EQUIPMENT

The **Transit** is the surveying instrument used to run lines, curves and turn-off angles. It is used mounted on a wooden tripod. A plumb bob suspended under the center of the transit is used to spot the transit directly over a particular point on the line.

Transit

A **Level** is essentially a powerful telescope equipped with a very accurate level. It is used in connection with a level rod to determine the elevation of a point. It also is mounted on a tripod when in use. It is more accurate for leveling than a transit.

Level

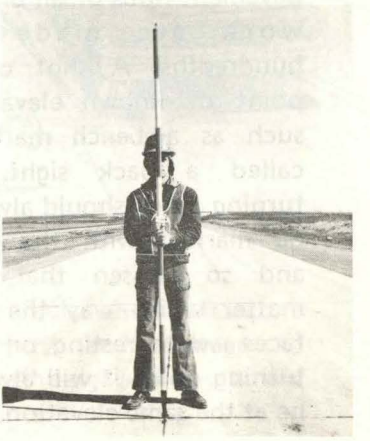
An **Engineer's Chain** is actually a 100-foot steel tape. The graduations are in feet with the first foot (sometimes an extra foot at the zero end) graduated in tenths of a foot. Hundredths of a foot (about one-eighth of an inch) may be estimated, unless the hundredth graduations are shown. Unless advised otherwise by the party chief, measurements are always made horizontally, not on a slope. This may require the use of a plumb bob at one end. A chain must be stretched taut when in use with about 15 pounds of tension. When very accurate measurements are made over long distances, a correction for temperature must also be made. The chain is equipped with leather thongs at each end to assist in holding the chain and to provide fastenings when the chain is coiled.

"Doing up" Chain

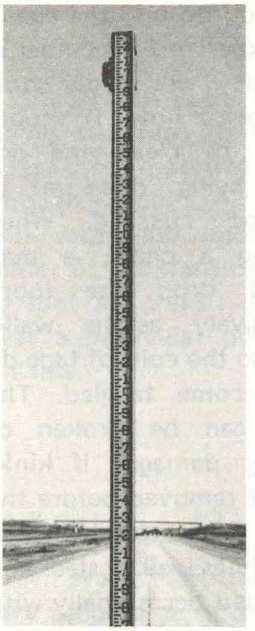
Every rodman should learn to "do up" the chain. Any experienced member in the party will gladly show the novice how. It should always be clean and dry before being "done up" to prevent rusting. When undoing a chain, a man should drop the loops successively as he walks along so the coils of tape do not become tangled. The chain can be broken or severely damaged if kinks are not removed before the chain is stretched. These rules regarding cleaning and kinking apply as well to steel box tapes. The tape should be dry and cleaned occasionally with an oily rag before rolling up.

Range Poles are of steel or wood with a steel point. They are painted in alternate 12-inch bands of red and white, and are used in setting points on a line. They are held facing the transit either on a point or as directed by the instrumentman. The range pole must always be held vertically. It sometimes happens that only a small portion of the top of the range pole is visible to the transit man. If the range pole is not held plumb a serious error might be made. When "giving line" to the instrumentman, if the entire range pole is not visible, it should be checked for plumbness with a plumb bob.

Level Rods are used to determine the elevation of a point. They read in feet (marked in red) and tenths and hundredths of a foot (marked in black). Level rods must also be plumb when used. When the rod reading is made to hundredths of a foot, it should be "waved" to enable the instrumentman to make an exact reading. Waving the rod means to



Range Poles

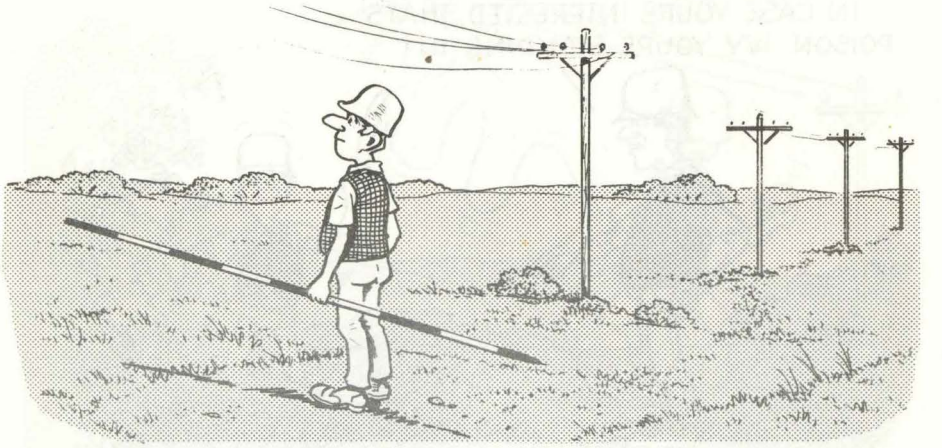


Philadelphia Level Rod

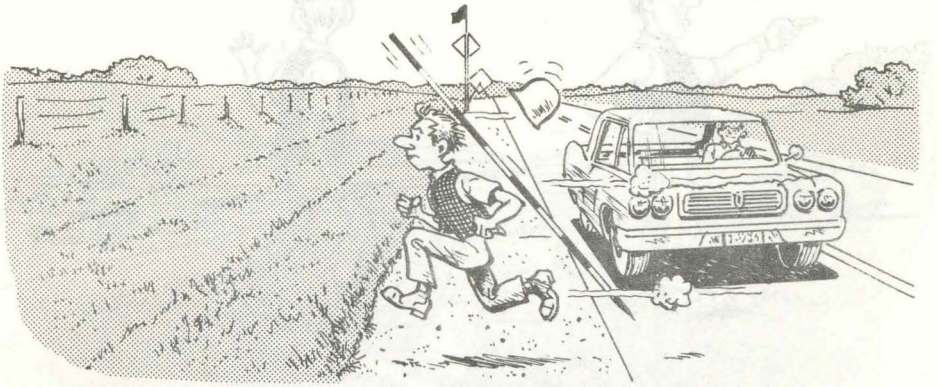
slowly lean the rod toward and away from the instrument, making sure it goes both ways from plumb. To determine the height or elevation of the level, a shot is taken on a "bench mark" or point of known elevation. The elevation of any point may then be known by subtracting the rod reading at that point from the height of the instrument. If it is necessary to move the level, a "turning point" is selected by the rodman. This should be a solid point such as a culvert headwall, fire plug, or a spot on a sidewalk, etc. Readings for turning points or on bench marks are always made to hundredths of a foot. Intermediate shots, such as for earthwork quantities, are made to the hearest tenth. However, readings on pavement hubs or all bridge work are made to hundredths. A shot on a point of known elevation such as a bench mark is called a back sight. A turning point should always be marked with the keel and so chosen that, no matter which way the rod faces, when resting on the turning point it will always be at the same elevation.

Self-Reading Rod

Safety Hints

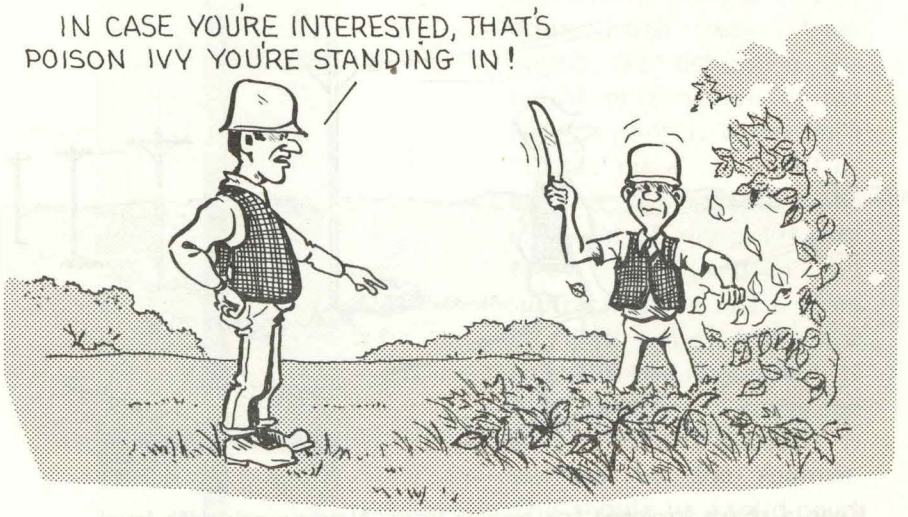


Keep a sharp lookout for power lines. Never work with level rods or range poles in close proximity to such line. Low lines should be reported to the Resident Engineer.

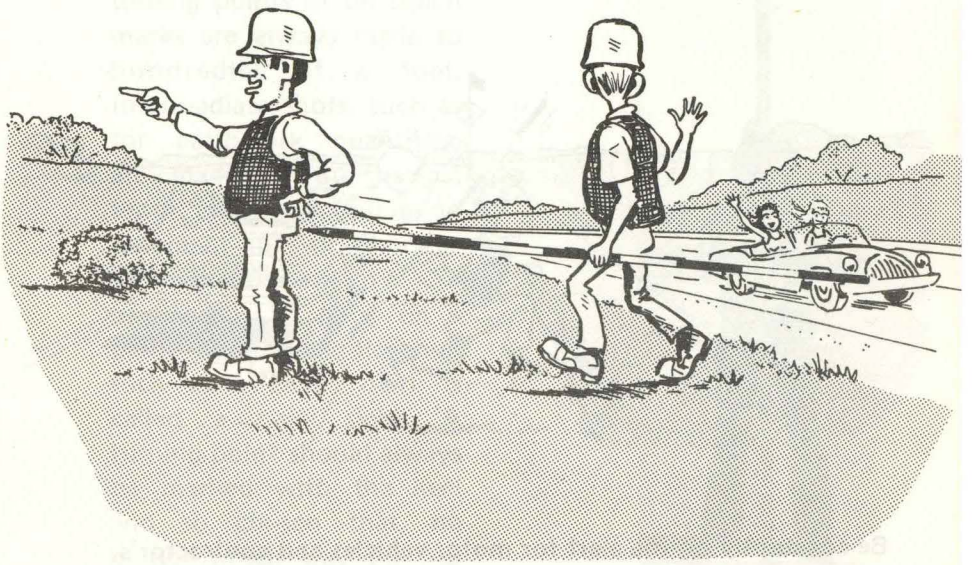


Be constantly on the alert for motor vehicles and contractor's equipment to avoid personal injury and damage to equipment. Remember that traffic has the right-of-way where traffic is maintained.

Learn to recognize poison ivy and poison oak. Immunity to such poisonous weeks at one time does not guarantee immunity at a later date.

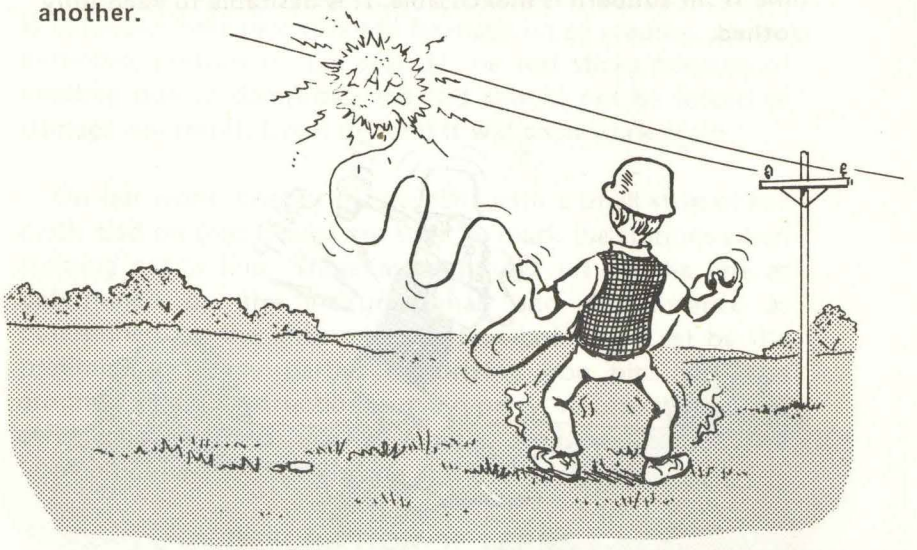


Remember hand axes, machetes, etc., have sharp edges and can inflict serious injury to your and others around you.

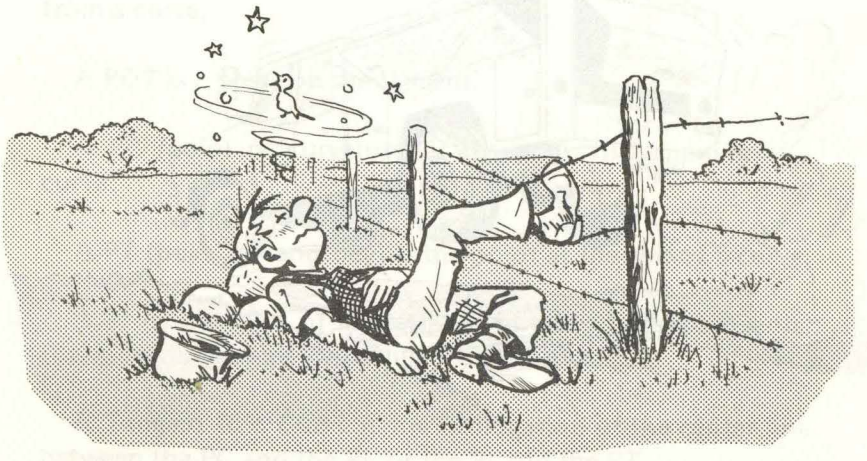


Never engage in horseplay. A range pole may make a fine javelin, but it is also a dangerous weapon.

Never ride on car fenders when moving from one location to another.

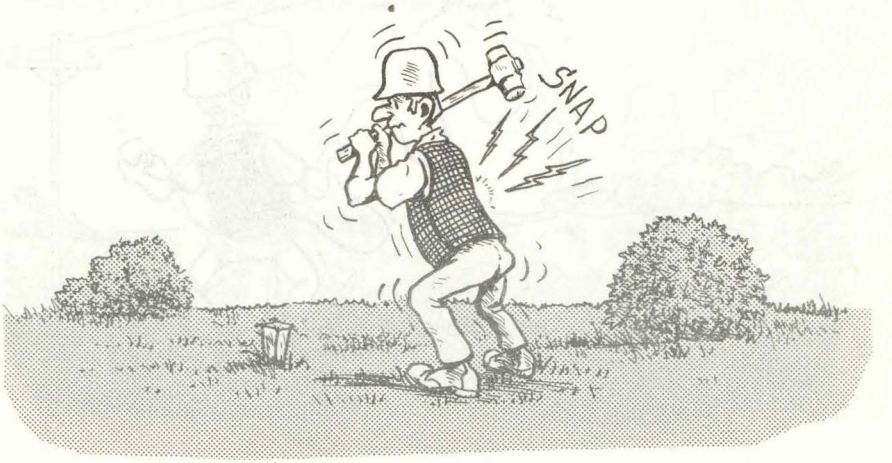


Use care in unrolling the cloth tape that you do not accidentally throw it over a power line. The cloth is reinforced with copper wire and severe injury or electrocution may result.

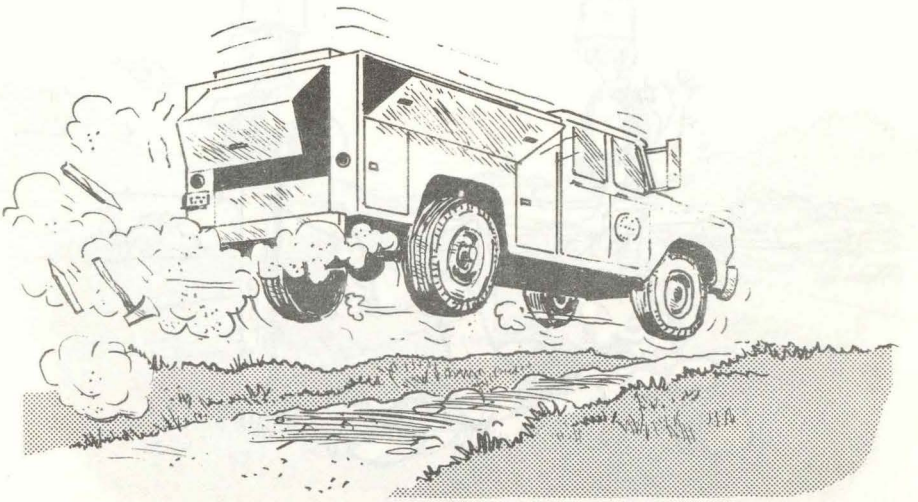


Be cautious when climbing over or off fences or jumping from one level to another. Landing on rocks, uneven or frozen ground can result in foot and ankle injuries.

Sunburn can be very painful and cause serious illness. Lost time from sunburn is inexcusable. It is desirable to keep fully clothed.



Back injuries are sometimes the result of improper use of mauls when driving hubs.



Load equipment into vehicles so the load does not shift while traveling. This will prevent broken windows and other damage to the motor vehicle.

When the rod is extended, care must be taken to see that it is extended fully or errors will be made on all readings on the extended portion of the rod. If the rod sticks because of swelling due to dampness, the rod should not be forced or damage will result. Let it dry and it will soon work again.

On our work, twenty penny nails with a small strip of red cloth tied on (red heads) are used to mark the stations when running out a line. These are carefully set on the line as determined by the instrumentman and the distance as determined by the chainman. Certain points are set by the preliminary survey parties by driving iron pins into the ground. The Construction survey party reruns these lines after locating these marked points. Any two consecutive known points establish the line at that location.

DESCRIPTION OF TERMS

Road centerline distances are measured in stations of 100 feet. The stationing is shown on the plans. A plus is the distance from the previous station to a point. For example, a culvert may be located at station 51+10.5, which means it is 10.5 feet beyond station 51.

A **Tangent** is a straight section of the line as distinguished from a curve.

A **POT** is a point on the tangent.

A **PC** (point of curvature) is the point of beginning of a curve.

A **PT** (point of tangency) is the point at the end of a curve.

A **PI** is the point of intersection of two adjacent tangents. It will lie outside the centerline of the curve.

A **Tangent to a Curve** is the prologation of the center line between the PC and the PI, or the PI and the PT.

A **POST** is a point on the tangent to a curve, and is established because of an obstruction in the line of sight on the curve tangent.

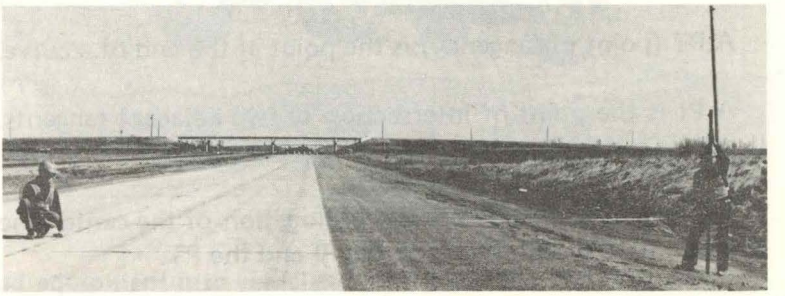
An **Offset Line** is one parallel to a given line at a certain distance away. The exact line is shown by driving lath nails into the hubs.

Hubs are usually 2x2x15 inches, driven flush with the ground.

Flats are flat, triangular stakes made by sawing a 1x4x15 inch diagonally. They are used for indicating the cut or fill elevation from the top of the hub to a point on a structure or pavement, or as slope stakes.

Slope Stakes are flats showing thereon the cut or fill to a ditch grade or shoulder elevation. A cut of 2 feet with the top of the back slope 30 feet from centerline would be indicated on the slope stake thus: $\frac{C2.0}{30.0}$ and a fill of 2 feet with toe of slope 30 feet from centerline would be shown as $\frac{F2.0}{30.0}$

Cross-sectioning is done by taking rod readings at the centerline and enough other points on the ground to permit plotting the surface at right angles to the centerline at its actual elevation. The distance from the base line (usually the centerline) for each shot is recorded with the rod reading. When final cross sections are plotted on the same sheet of paper, the cross sectional area of the cut or fill can be measured. The area in square feet of cut or fill is averaged



Cross-Sectioning

between two adjacent cross sections. When the distance between cross sections in feet is multiplied by the average end area and the product divided by 27, the result is the number of cubic yards of cut or fill. When taking cross sections, a shot on the ground at every break in the surface must be taken. Also, the line of shots for the section must always be at right angles to the base line. Original cross sections must extend beyond any disturbance caused by the grading operations so that when the finals are taken the sections will close.

To **Reference a Point**, such as a POT, the transit is set up over the point. Four hubs (or concrete monuments if a permanent reference is being made) are set beyond the area to be disturbed so that the diagonals of the four hubs intersect at the point being referenced. The horizontal distance to each hub is measured to the nearest one hundredth of a foot. To reset the point, the transit is set on one hub, sighted on the diagonal hub, and a string line set so that a similarly set string from the other pair of hubs will intersect over the point desired. If an established pin is to be found, intersecting arcs swung from any two reference hubs will indicate the place to dig to uncover the point sought.

SIGNALS

Various hand signals are used during the process of surveying.

When setting a point on a line, the instrumentman signals the rodman to move left or right to set the point. The signal is a wave of the hand or arm in the direction required. The longer the wave the farther the movement. When only a very small movement is necessary, the signal is a sharp movement, either of the hand or a white cloth if the distance is great.

When the point is properly located on line, both arms are outstretched simultaneously.

"Plumb Right"

In leveling, when the instrumentman has taken the rod reading, a wave of the hand tells the rodman that he may proceed to the next rod location.

When a turn is desired, the instrumentman makes a rotating motion with one arm directly over his head.

CONCLUSION

Much of what a rodman must know can only be learned from experience. A careful study of the foregoing can, however, assist a new rodman to grasp the fundamentals of his job and shorten the period of apprenticeship. Don't be afraid to ask questions. An alert, inquisitive attitude coupled with a desire to work and learn can only result in high proficiency and, eventually, promotion.

Learning is a continual process. As you work, you will learn. However, you can advance faster in ability by reading any good surveying text. Your resident engineer will gladly loan you his or help you find one for evening study.

A booklet explaining the activities of a new employee would be incomplete without a few words of advice in regard to personal behavior on and off the job.

Remember that a good worker is a careful worker. Safe practices should be observed in every operation. The use of safety equipment is of prime importance to every man on the party. Wear safety vests at all times when working within the right of way of a traveled highway. If working around or near

machinery or where there is danger of falling objects, safety helmets should be worn. Look after your safety and the safety of your fellow workers at all times. Particular attention should be paid to safe driving and to the care and upkeep of your survey vehicle.

At times certain safety equipment, such as safety goggles or glasses, hard-toed shoes, etc., may be needed. Your supervisor will instruct you, when conditions create hazards that may injure you, or issue available equipment.

Care should be taken to avoid injury to private property. Shrubs and growing crops should not be damaged. When blazing trees for removal, make sure you are inside the right of way or you will subject the state to a claim for damages.

Be on your guard against idle gossip about other employees or the operation of the Highway Commission. Suggestions for improvements should be taken up with your superior. Don't hesitate to admit your lack of knowledge if asked about something with which you are not familiar, the wrong answer may cause extensive embarrassment for you and others.

Always remember that in the mind of the public you represent the Highway Commission and any acts or omissions on your part go far in forming public opinion of this state organization.

By industry and application you can place yourself on the ladder of promotion and before long be the man behind the "gun" directing your own party.

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IOWA STATE HIGHWAY COMMISSION

CONSTRUCTION DEPARTMENT