STEREO-TERRESTRIAL-PHOTOGRAMMETRY FOR HIGHWAY RESEARCH

D. J. BELCHER and G. B. LYON*

Terrestrial photographs taken with garden-variety cameras have provided much qualitative information about the use, and misuse, of highways and about the failure of specific features, such as slopes. Quantitative information about the use, misuse, and features can be obtained easily and quickly, day or night, if existing metric-quality terrestrial stereo cameras are properly used. This proper use can be quickly and easily learned by the instrument men of any competent survey party, as well as by many other persons.

The Geotechnical Engineering Department of the School of Civil Engineering of Cornell University is studying the movement of landslides by plotting topographic maps of slide areas from photographs taken with such a terrestrial stereo camera system. The unique approach used in this study is believed to be of interest to many areas of highway research.

The patterns of movement of soil masses within the slide area may range from very simple to very complex. One very simple pattern may be similar to that of a block of ice sliding on an inclined plane. A very complex pattern might well be a general movement, variable within the slide area, upon which the relative movements of portions of the entire moving mass are superimposed. The general movement, in some slides, may be negligible along certain boundaries of the area but much greater in the central portion of the slide.

One common approach used in studying earth movement is to set permanent monuments within the moving area and to periodically locate these monuments, with respect to other monuments set outside the slide area, by traditional surveying methods. The change in position within the slide area between sets of observations provides a measure of the amount and direction of movement. Unfortunately, the required depth of embedment of the permanent monuments may distort or even conceal the pattern of actual movement. Furthermore, if these monuments are not deeply embedded they are easily lost or removed by unthinking individuals.

An alternative approach is to make a complete topographic survey of the slide region on different occasions. The superposition of the resulting maps will reveal the changes in position of the contour lines. These changes in position represent the amount and direction of the movements during the intervening period. There are several disadvantages of the use of traditional surveying procedure in this method:

1. A very large number of points in the slide area must be located in order to obtain a satisfactory topographic map for this purpose.
2. The selection of the proper points in the field is predicated to a considerable degree on a preconceived pattern of movement, in order to reduce the number of points to be located.

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*D. J. Belcher is Professor of Civil Engineering and G. B. Lyon is Associate Professor of Civil Engineering at Cornell University, Ithaca, N.Y.

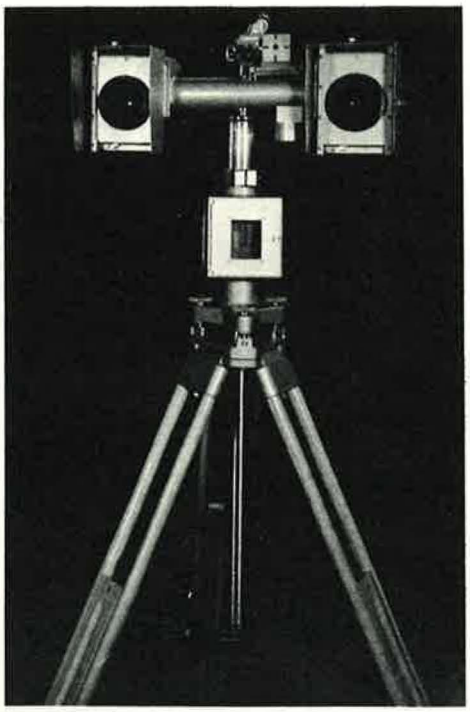

Figure 1. A Zeiss SMK camera system is used to make terrestrial photographs.

3. Mistakes in the field work required for the location of each detail point impair the quality of the map. Since the slide area is in motion, the field party cannot go back to repeat the field work.

These topographic maps may also be compiled by the use of metric-quality terrestrial stereophotographs and appropriate stereoplotters. The required field survey work is limited to the location of four to eight permanently monumented points outside the slide area. This small number of points can be located with respect to each other by surveys, incorporating a considerable number of independently redundant measurements. The additional cost of the redundant measurements is very small. If mistakes in this work are discovered, the field survey work can be repeated. The photographs are taken from the vicinity of one or more of these monumented points and accurately located with respect thereto. At least two of the remaining points are signalized so that images of these signals appear in the photographs.

These stereophotographs provide a permanent record of the positions of thousands of points in the slide area. This record may be examined and reexamined, as desired, in the comfort of the office or photogrammetric plotter room, in order to further clarify a possibly ambiguous interpretation of the earlier maps.

A single mapping of a half-acre site containing a landslide has been accomplished with about one hour of time on site of a three-man field party, taking the stereophotographs with a Zeiss SMK camera system, and about eight hours of work of an operator on the Zeiss Terragraph stereoplotter. The time required for the original layout and placement of permanent monuments at the control points and the measurement of the angles and distances, including the redundant observations for the detection of mistakes, required less than three hours on site by a three-man party.

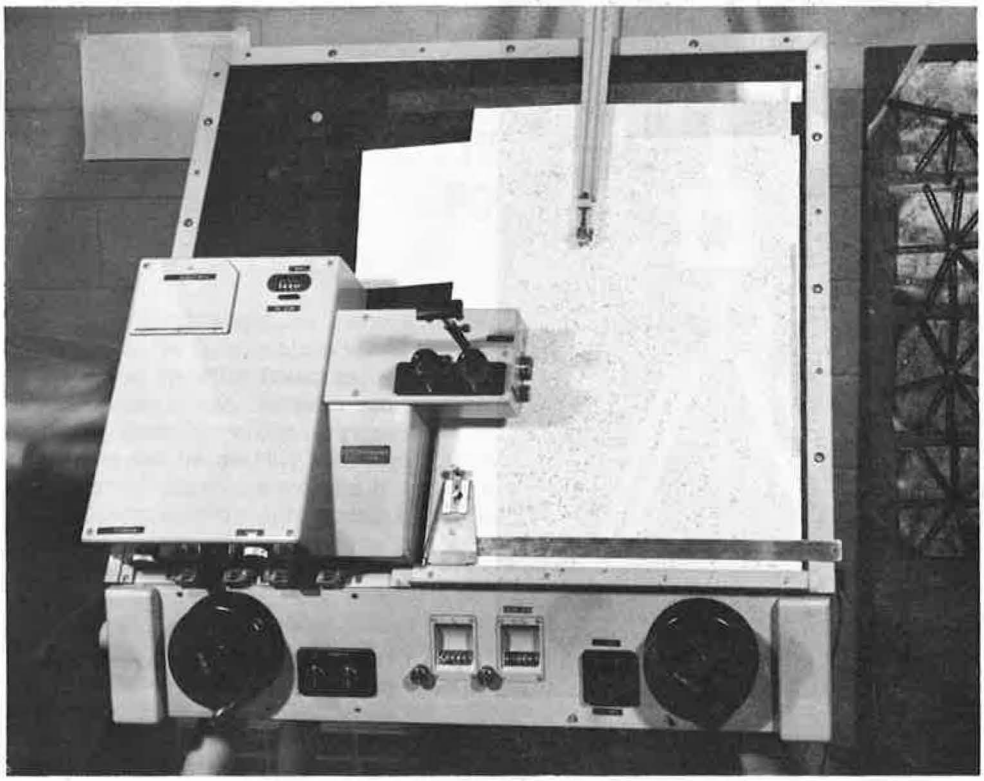

Figure 2. A trained operator can map a half-acre site within eight hours using this Zeiss Terragraph stereoplotter.

This same terrestrial stereophotogrammetric mapping system also provides the opportunity to quickly record the physical circumstances resulting from vehicle accidents. Subsequently, studies of each accident can be made from maps compiled on the Terragraph from the stereophotographs. Although some information regarding the accident can be obtained by on-site measurements made by the officers at the time of the accident, more information can be derived from the stereophotographs, with less likelihood of omitted or incorrect measurements. Stereophotographs taken from different positions around the accident site can be combined if at least three readily identifiable landmarks (such as power poles or guardrail posts) appear in the field of view of each set of stereophotographs. The use of photo flash equipment permits the making of photographs at night immediately after an accident.

These landmarks can be used as survey control points, as in the traditional three-point resection problem. Any necessary measurements needed to determine the relative position of these landmarks can be made in daylight.

A number of police departments in Europe use this terrestrial photogrammetric system for collecting information about accidents. The camera system could be a part of the equipment carried in each police car. However, a more common practice is to train a few officers in the police department to use this equipment and summon them, as needed, by radio.

Although our experience with terrestrial stereophotogrammetric equipment has been limited to that manufactured by Carl Zeiss, Inc., the Wild-Heerbrugg

Instrument Company also has a similar line. Both of these companies also manufacture units consisting of single metric-quality cameras that can be used to take photographs for the purposes described above, as well as others. However, the use of the photographs taken with this system is somewhat more difficult than the use of the stereo camera system.

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