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INSTRUMENTATION AND PHOTOGRAPHIC TECHNIQUES FOR DETERMINING DISPLACEMENTS, VELOCITY CHANGE, AND DECELERATION OF VEHICLES WITH BREAK-AWAY SIGN STRUCTURES

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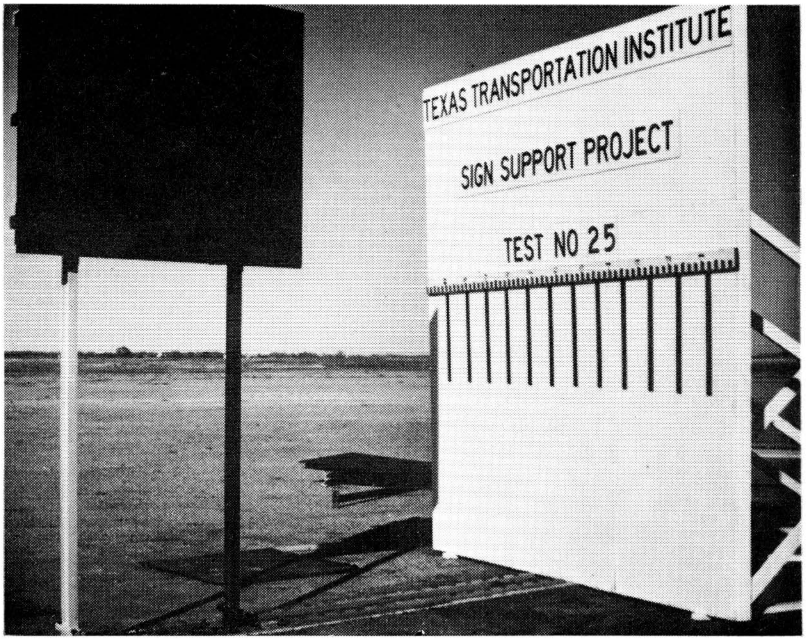

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Instrumentation and Photographic Techniques for Determining Displacements, Velocity Change, and Deceleration of Vehicles with Break-away Sign Structures

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Contemporary highway design provides for vehicle operation at high speed on multilane roadways. Exit ramps must be provided for egress from such facilities. Each vehicle operator traveling on a highway at a legal speed must make decisions concerning lane selection and exit ramp choice if he is to reach his destination. Guide signs are installed to aid an operator in this decision making process. Location, design, and construction of such signs on the Federal Interstate Highway system are accomplished in accordance with policies established by the American Association of State Highway Officials. Engineers in the several state highway departments have discretionary authority in interpretation of the broad AASHO policies.

A two-post cantilever sign support design is widely used; it consists of a pair of vertical cantilever flange beams which are economical, strong, and stable when subjected to wind forces. It has aesthetic quality, supports a readable sign, and is located adjacent to the roadway. In short, the sign support is excellent, but lethal. It is this last characteristic which has motivated the present research.

The Texas Highway Department and the Texas Transportation Institute have been actively engaged in studies[1,2*] of the impact behavior of certain sign supports. The aim of these studies has been the development of a two-post sign support which would present less of a hazard than the conventional AASHO design. The investigators introduced certain mechanical devices into each post, these devices permit the post to be released at its base upon impact and to be deflected in front of and above the crash vehicle. The primary break-away device is located at the base of the support post. It is fabricated by making a right-angle cut across the beam, welding plates to the adjacent post pieces, and reconnecting the pieces by bolting them together. The adjacent plates have slots which permit the bolts to become disengaged upon impact by a vehicle.

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*Superscript numbers refer to items listed under References.

A secondary "plastic hinge" joint is fabricated in the post at the lower edge of the sign face. This joint consists of a right-angle cut cross the forward flange and part of the web of the beam. The cut is terminated at the fillet of the rear flange and the forward flange is reconnected by a mechanical fuse. The fuse consists of either a cast-iron plate which is designed to fracture upon impact or a slotted steel plate which is designed to slip upon impact. The purpose of the fuse is to permit the break-away post section to be elevated over the crash vehicle. Each support post has a break-away base and a "plastic hinge" joint. Only one support post is struck by the crash vehicle in this series of tests.

The initial phase of the earlier studies resulted in the development of a full-scale crash test facility. A high-speed motion picture camera was employed to record the behavior of the sign support and automobile during a controlled collision.

The procedure employed in developing the break-away sign posts consisted of fabrication, testing, viewing films, making modifications, and re-testing. This process resulted in design modifications which were adopted by the Texas Highway Department and were incorporated into their design and construction standards. The philosophy of this initial series of tests was to ascertain the phenomenological behavior of the sign supports, and to make modifications and improvements. The method has been characterized as phenomenological because the behavior of the post is evident, but not quantitatively interpreted or explained.

A series of six full-scale instrumented crash tests employing an automobile towed into a collision with one support of a two-support highway roadside sign was conducted; these six instrumented tests were part of a research program embracing a total of forty-three crash tests. The series considered in this report was conducted to acquire, reduce and correlate electronic and photographic data. Conventional fixed-base sign supports were struck in two of the six tests, and break-away base sign supports were struck in the remaining four tests.

High-speed motion picture films were made of each of the crash tests. These films provided a Displacement-Time record of each collision. A piezoelectric accelerometer was installed on the frame of each crash vehicle. The signal from this accelerometer was transmitted to a recording oscillograph, and a trace of the accelerometer behavior was recorded on light sensitive paper. This trace provided an Acceleration-Time record of each collision. Other electronic instrumentation was installed in order to obtain Strain-Time information about the collision.

A method of successive summation of areas contained by the Accelerometer trace is presented which results in a Displacement-Time plot which has been compared with the corresponding data recorded from examination of the high-speed films.

Examination and comparison of information from each of the records obtained has led to a time dependent description, or chronology of collision.

The general objective of the present research was to produce this time dependent description of vehicle and break-away support post behavior during a collision incident. In addition to the general objective, the specific objectives were: (1) to develop a technique for acquiring and reducing high-speed film data of the collision incident, (2) to develop a technique for reducing and analyzing data from an accelerometer mounted on the frame of the crash vehicle, (3) to correlate the information from the two data gathering systems, (4) to secure information concerning strain and stress in elements of the "plastic hinge" joint during the collision incident, and (5) to determine the force in the support post at bumper height during the collision incident.

An examination of the literature relating to crash research leads one to the conclusion that data gathering techniques have improved considerably during the past twenty years; however, it is apparent that data reduction and analysis have lagged behind the improved instrumentation capabilities. The literature reviewed contains many references to methods of instrumentation and presents data records from crash tests, but none of the investigators has presented a correlation of data from the independent gathering systems. In the present study a correlation of data from independent systems has been accomplished and original descriptions of collision incidents have been presented.

References

1. Samson, C. H., Rowan, N. J., Olson, R. M., and Tidwell, D. R., "Impact Behavior of Sign Supports," Research Report 68-1, Texas Transportation Institute, College Station, Texas, March 1965.
2. Rowan, N. J., Olson, R. M., Edwards, T. C., Gaddis, A. M., Williams, T. G., and Hawkins, D. L., "Impact Behavior of Sign Supports—II," Research Report 68-2, Texas Transportation Institute, College Station, Texas, September 1965.