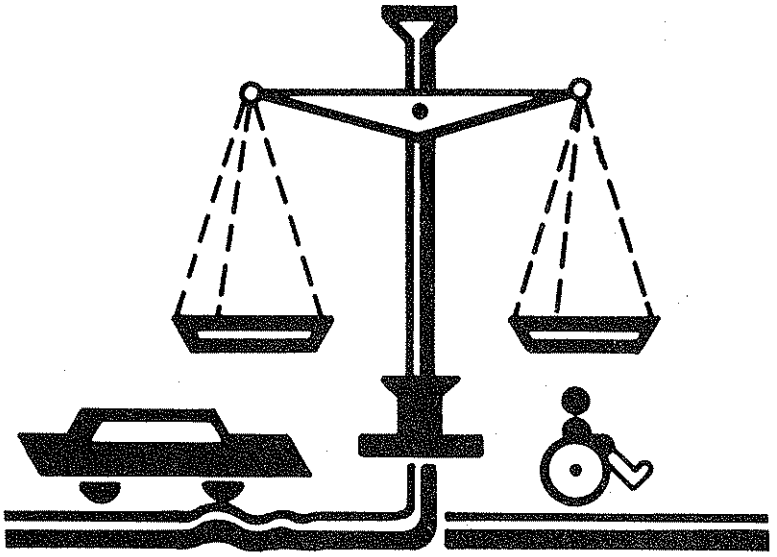
R. L. CARSTENS
J. V. DICKINSON
SEPTEMBER 1979



FINAL REPORT

SAFER CONSTRUCTION AND MAINTENANCE PRACTICES TO MINIMIZE POTENTIAL LIABILITY BY COUNTIES FROM ACCIDENTS

Iowa Highway Research Board
HR-204

ISU-ERI-Ames-80016
Project 1379

In cooperation with the
Highway Division,
Iowa Department of Transportation

R. L. CARSTENS, J. V. DICKINSON SAFER CONSTRUCTION AND MAINTENANCE PRACTICES *** SEPTEMBER 1979 ISU-ERI-Ames-80016

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R. L. Carstens
Principal Investigator

J. V. Dickinson
Graduate Research Assistant

September 1979

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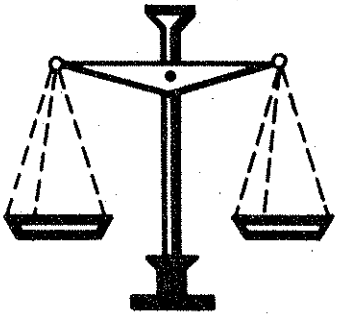
DEPARTMENT OF CIVIL ENGINEERING
ENGINEERING RESEARCH INSTITUTE
IOWA STATE UNIVERSITY, AMES, IOWA 50011



EXECUTIVE SUMMARY

Tort claims resulting from alleged highway defects have introduced an additional element in the planning, design, construction, and maintenance of highways. A survey of county governments in Iowa was undertaken in order to quantify the magnitude and determine the nature of this problem. This survey included the use of mailed questionnaires and personal interviews with County Engineers.

Highway-related claims filed against counties in Iowa amounted to about $52,000,000 during the period 1973 through 1978. Over $30,000,000 in claims was pending at the end of 1978. Settlements of judgments were made at a cost of 12.2% of the amount claimed for those claims that had been disposed of, not including costs for handling claims, attorney fees, or court costs. There was no clear time trend in the amount of claims for the six-year period surveyed, although the amount claimed in 1978 was about double the average for the preceding five years.

Problems that resulted in claims for damages from counties have generally related to alleged omissions in the use of traffic control devices or defects, often temporary, resulting from alleged inadequacies in highway maintenance. The absence of stop signs or warning signs often has been the central issue in a highway-related tort claim.

Maintenance problems most frequently alleged have included inadequate shoulders, surface roughness, ice or snow conditions, and loose gravel.

The variation in the occurrence of tort claims among 85 counties in Iowa could not be related to any of the explanatory variables that were tested. Claims appeared to have occurred randomly. However, using data from a subsample of 11 counties, a significant relationship was shown probably to exist between the amount of tort claims and the extensiveness of use of warning signs on the respective county road systems. Although there was no indication in any county that their use of warning signs did not conform with provisions of the Manual on Uniform Traffic Control Devices (Federal Highway Administration, Government Printing Office, Washington, D.C., 1978), many more warning signs were used in some counties than would be required to satisfy this minimum requirement.

Sign vandalism reportedly is a problem in all counties. The threat of vandalism and the added costs incurred thereby have tended to inhibit more extensive use of traffic control devices. It also should be noted that there is no indication from this research of a correlation between the intensiveness of sign usage and highway safety.

All highway maintenance activities introduce some extraordinary hazard for motorists. Generally effective methodologies have evolved for use on county road systems for routine maintenance activities, procedures that tend to reduce the hazard to practical and reasonably acceptable levels. Blading of loose-surfaced roads is an example of such a routine maintenance activity. Alternative patterns for blading that were investigated as part of this research offered no improvements

in safety when compared with the method in current use and introduced a significant additional cost that was unacceptable, given the existing limitations in resources available for county roads.

Eight recommendations resulted from this research. These are directed toward reducing the potential exposure of counties to tort liability. Recommendations are as follows:

1. Follow strictly the provisions of the Manual on Uniform Traffic Control Devices in the use of warning signs.
2. Establish a coherent and carefully documented policy governing the use of stop signs.
3. Establish a continuing sign inventory process.
4. Establish written agreements covering county line roads that clearly delimit responsibilities.
5. Use a ball bank indicator to establish advisory curve speeds where needed.
6. Establish a road and sign inspection program.
7. Establish a program to document conditions surrounding accidents on roads under county jurisdiction.
8. Develop procedures to assure timely notification of accidents on roads under county jurisdiction.

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ACKNOWLEDGMENTS

The research reported here was sponsored by the Iowa Highway Research Board and was carried out by the Engineering Research Institute, Iowa State University. Financial support was afforded by the Iowa Department of Transportation and the Engineering Research Institute.

Research personnel wish to extend their gratitude to the 85 County Engineers, and other county officials, who assisted by completing questionnaires to afford factual input to this research. The following County Engineers were especially helpful by consenting to be interviewed or assisting with preliminary questionnaires or supplemental studies:

Roy E. Ellerhoff, Cedar County

William A. Bauer, Chickasaw County

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Kenneth M. Wallace, Lyon County

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Charles E. Hales, Pottawattamie County

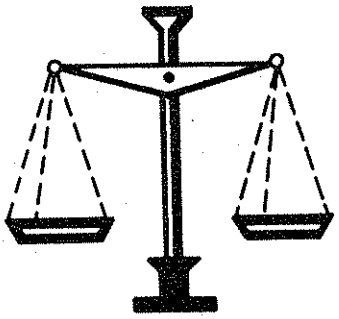
Eldo W. Schornhorst, Shelby County

Del S. Jespersen, Story County

The interpretations of factual input to the research, opinions, findings, and conclusions are those of the authors and are not necessarily consistent with the opinions of personnel from the Iowa Department of Transportation or the Iowa County Engineers Association.

I. INTRODUCTION

Background for the Study



The 99 counties in Iowa are responsible for construction and maintenance of a secondary road system including approximately 90,000 miles of highways. Nearly 3.5 billion vehicle-miles of travel took place on this system in 1977. This travel resulted in approximately 200 fatalities.

Each accident occurring on a county highway, and especially each serious accident, introduces the potential for a damage claim against the county. Since each road segment is imperfect in some respect, some basis for a claim can grow out of any highway accident.

The legal basis for damage claims against counties is afforded in Iowa by several sections of the Code of Iowa [1].* Chapter 613A permits claims and suits against counties for tort damages. The general responsibilities of counties relative to maintenance of their highway systems are set forth in Section 309.67. This section charges the supervisors and engineer to keep secondary roads "in the best condition practicable" and provides specific details as to certain maintenance tasks. Section 321.252 requires that local traffic control devices conform to the state manual and specifications. Section 321.255 directs

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*Numbers in brackets denote references at the end of this report, page

local authorities to place such traffic control devices "as they may deem necessary." Certain other sections afford further direction to county authorities relative to highways. Examples include 321.342 (on particularly dangerous highway grade crossings of railways), 321.345 (on stop and yield signs), and 321.352 (on additional warning signs at unusually dangerous places). An alleged failure to perform properly the duties enumerated in one or more of these sections provides the usual basis for highway-related tort claims against counties.

The goal of providing a perfect highway, one that would provide no basis for damage claims, will never be achieved. Fiscal limitations preclude the vastly greater expenditure for highways that would be required to approach this goal. Moreover, there is considerable evidence that current levels of highway expenditures reflect the viewpoint of a majority of citizens regarding the value of highway safety. The public has demonstrated little willingness to support substantially increased outlays for safety measures.

County Engineers are all aware of the limitations and imperfections inherent in secondary road systems. However, fiscal constraints have limited their capability to adhere to rigorous standards of practice for highway construction and maintenance. Whereas counties are concerned largely with roads carrying very low volumes of traffic, most generally accepted standards were formulated to apply primarily to high volume facilities.

Unfortunately, none of the seemingly valid reasons for adhering to lesser standards affords a suitable defense in litigation. A seriously injured plaintiff, or relatives representing the estate of a person

killed in a highway accident, will exploit any discrepancy between an ideal standard and the imperfect highway segment where an accident occurred.

Given these constraints and the expressed concerns of county officials regarding the frequency and magnitude of tort claims resulting from highway accidents, this research was undertaken to quantify the problem and to seek solutions. Desired solutions would make travel on county highways safer and reduce the frequency and magnitude of claims.

The solutions sought were not those involving massive expenditures such as would be required to reconstruct and upgrade all substandard portions of the secondary road system. Instead, the solutions were assumed to be constrained by realistic fiscal limitations and were designed to render the existing system, without significant modification, safer for travel. Measures were especially sought that related to construction and maintenance practices and were readily capable of implementation by county governments.

Adoption of the measures recommended may be expected to lead to the more efficient use of funds available for highways under county jurisdiction. A greater proportion of available funds could be expended for the construction and maintenance of secondary roads if a decreased proportion were required to satisfy negligence claims and for liability insurance.

Project Overview

Research Goal and Purposes

The goal of this research was to improve highway safety and reduce the potential liability of counties from accidents relating to alleged imperfections in highway facilities or in connection with essential highway-related activities. This goal was addressed by focusing upon those safety problems that actually have resulted in highway-related tort claims against counties.

The purpose of one intermediate step in the accomplishment of this goal was to establish the magnitude of the problem of tort claims against counties in Iowa that relate to alleged deficiencies in highway facilities or in construction and maintenance practices. The number and dollar amount of county highway-related tort claims for the years 1973 through 1978 were determined in order to evaluate yearly trends. The number and dollar amounts of settlements or judgments and the number and dollar amounts of the claims pending were also determined.

A further purpose of this stage of the research was to determine the specific problem areas that have caused accidents giving rise to claims. An evaluation could then be made as to which problems had given rise to the largest amounts of claims, settlements, and cases pending.

Data obtained from the counties were also analyzed to determine whether any significant relationships could be established between the historical tort claims experience and the locations, demographic characteristics, or highway system characteristics of the counties. The purpose of this analysis was to identify any factors that demonstrated

a significant correlation with claims experience in order to suggest measures that might be useful for reducing the potential liability from highway-related tort claims.

Based on the conclusions from the research, recommendations were formulated relating to highway construction and maintenance practices, including the use of traffic control devices, that addressed the causative factors identified as leading to tort claims against counties.

Three relevant considerations were set forth to guide the formulation of recommendations.

First, they were to be consistent with generally accepted practices in highway or traffic engineering. They must be clearly related to the construction and maintenance standards and manuals that are commonly cited as guides for county engineering practices.

Second, methods of implementation were to be set forth in sufficient detail so that a complete response would result if the guidelines were followed. This requires that the equipment and methods of response be appropriate to the resources of a county road department and does not require sophisticated items of equipment or highly specialized personnel not normally available at this level of government.

Third, the guidelines must be carefully structured so that they can not serve as an additional exhibit suitable for use by a plaintiff in supporting allegations of negligence. Rather than imposing additional work requirements, the guidelines were to be a systematic compilation and consolidation of the most important requirements that are currently available in a variety of sources. The important distinction must be

emphasized that these suggestions constitute guidelines and are not an additional manual of recommended practices.

Research Approach

The technical literature was reviewed for articles and other publications that pointed out the problem areas that have afforded or may afford a basis for a tort claim against a highway agency. The results of this review are summarized in Chapter II of this report.

In order to determine the highway-related tort claim experience of counties in Iowa, a mailed survey was directed to each county. A description of this questionnaire and a summary of responses is provided in Chapter III of this report. The tort claims experience reported by counties has been summarized so as to display the bases for claims and permit an assessment of the frequency of occurrence and the monetary liability associated with each problem area.

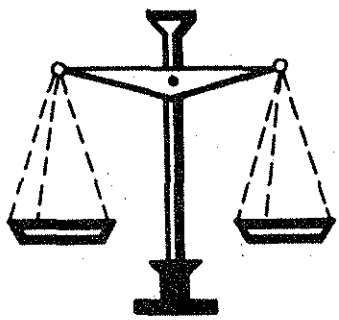
Following receipt of the questionnaire responses, personal interviews were conducted with several County Engineers. The nature of these interviews and the findings resulting from them are summarized in Chapter IV.

Chapter V describes the statistical analysis that was undertaken for the data set of tort claim experience by county. Also described in this chapter are three supplemental studies that were undertaken to address specific areas of concern in the maintenance of secondary roads. These supplemental studies covered in some detail the following problem areas:

- Use of warning signs
- Routine blading of loose-surfaced and unsurfaced roads
- Curve advisory speeds.

The conclusions and recommendations resulting from this research are presented in Chapter VI. Recommendations, prior to their inclusion in the report, were reviewed by members of the Executive Board, Iowa County Engineers Association, and by other knowledgeable persons. These persons were asked to comment and offer suggestions as to items that might have been overlooked or additional details as to response procedures. Their suggestions have been incorporated in the recommendations.

II. REVIEW OF RELEVANT LITERATURE



A number of references address the subject of tort liability resulting from highway-related activities. Most of these deal broadly with several types of highway-related tort liability [2-12]. Some are concerned with specific types of tortious acts or omissions such as those relating to the use of traffice control devices or those occurring in construction and maintenance work areas [13-23]. Many example cases are cited in these references.

Sovereign Immunity

Several of the references cited above trace the erosion of sovereign immunity in the U.S. from its origin in common law to the current situation (especially [4,5,22]). Most states have become liable for tortious governmental conduct, either by legislation or as a result of court decisions.

The following quotation summarizes the erosion process that has occurred relative to sovereign immunity:

> In essence, sovereign immunity meant that the government--in its abstract sense--could not be held liable when it was acting in its capacity as "governor." But the leveling influence of American democracy, the fast pace of commercial development, the rise of the philosophy of the welfare state with all its attendant social protection features, and the development of a uniquely

> American jurispredence have all chipped away at sovereign immunity until the erosion process has left the governor covered only by a shroud of protection, and that shroud, it appears, may be transparent.

Sovereign immunity was effectively nullified in Iowa by the enactment of Chapters 25A (in 1965) and 613A (in 1967), Code of Iowa [1].

Discretionary and Ministerial Functions

Several references discuss the differences between discretionary and ministerial functions (especially [5,6,21]). This distinction is significant under a majority of laws and judicial interpretations. In some jurisdictions a distinction may also be made between governmental and proprietary functions, the terms used in Chapter 613A, Code of Iowa, relating to claims against counties and cities.

Discretionary functions are those in which an individual acting on behalf of a governmental entity has the power and duty to make a choice among valid alternatives. These functions involve determinations with broad implications made by executives or administrators. Courts generally are reluctant to impose their judgments on decisions arrived at in a rational manner by officials responsible for exercising judgments requiring special knowledge and experience. Highway planning and design activities generally have been held to exemplify exercise of a discretionary function.

Ministerial functions, on the other hand, are those that require a minimum of judgment and do not entail significant evaluation or weighing of alternatives before undertaking the duty to be performed. Highway maintenance activities that are carried out within the framework of

broad policies and guidelines are considered ministerial functions. Construction has been held to be ministerial when it deviates from an approved design or where there has been negligence in implementing a design.

Claims against the state for exercise of a discretionary function or duty are specifically precluded under Chapter 25A, Code of Iowa. However, Chapter 613A pertaining to claims against counties and cities imposes liability "whether arising out of a governmental or proprietary function." There are virtually no highway-related activities carried out by counties in Iowa that are barred from tort claims.

Standard of Care

The standard of care required of an employee of a highway agency is set forth in a number of the references cited (especially [2,8,19]). It is also set forth in a substantial number of judicial decisions rendered in cases used in these references to illustrate the problems of tort liability.

Employees serving the public are expected to exercise reasonable care in the performance of their duties. For one charged with responsibilities for public highways, this requires adherence to generally accepted standards and practices. Hence, decisions as to liability are made by comparing the actions taken in planning, design, construction, and maintenance of highway facilities with the reasonable actions of a prudent person and with those standards and practices that have gained general acceptance in the highway field. Greatest wieght will be given to written standards that have been formulated and adopted locally.

However, all applicable policies and publications that have acquired nationwide or statewide recognition from highway agencies and organizations may be used as evidence in establishing the general acceptance of a standard or practice that may be at issue in connection with a claim.

Highway agencies are not required to guarantee safety to travelers on public highways. They are required only to make and keep roads in a reasonably safe condition for the reasonably prudent traveler. However, the motorist using a public highway has the right to assume that a road is safe for the usual and ordinary traffic. A driver is required only to anticipate the usual risks associated with highway travel and is not required to anticipate extraordinary danger, impediments, or obstructions to which his or her attention has not been directed.

Negligence and Tort Liability

Failure of a public entity providing highway service to exercise reasonable care may lead to an allegation of negligence, the usual basis for a tort claim. In order to sustain a claim based on negligence, the following conditions must be satisfied.

1. There must be a showing that the claimant sustained a loss. Personal injury or damage to property may constitute such a loss.
2. It must be demonstrated that the public entity had a duty towards the claimant. The responsibility to provide reasonably safe highways is an appropriate duty in this regard.

3. It is necessary to show that there was a failure to exercise reasonable care in the performance of that duty, that the actions taken were not those of a prudent person or there was failure to adhere to generally accepted standards or practices.
4. It also must be shown that negligence on the part of the public entity was the proximate cause of the loss to the claimant. A claimant must demonstrate that but for the negligent act of the highway agency or its employees the incident causing the loss or damage would not have occurred.
5. The highway agency must have had notice of the defect that led to the incident giving rise to a claim. Notice may be actual, suggesting that information concerning the negligent act or omission had been in the possession of the highway agency. Or there must be a showing that there was constructive notice, that a prudent person should have known of the alleged defect.

Many of the problems giving rise to tort claims develop from highway maintenance activities. This includes a broadened definition of maintenance to include normal traffic operations and control. Highway planning, design, and construction operations involve lesser risks of tort liability.

Those charged with evaluating tort claims, including judges and jurors, have the advantage of hindsight. On the other hand, the manager of highway maintenance activities must plan his or her actions in anticipation of the effects on the traveling public. The necessary course of action is described by Jones [4] as follows.

> Stop relying on legal defenses and insurance to totally protect your county from liability. The cost of this approach is now or soon may be prohibitive. I urge you to tighten up your maintenance procedures and activities the best you know how. Advise and instruct your personnel down to the lowest maintenance man what is involved; that not only the county, but the individual employee is vulnerable to liability. Train your people to apply the "reasonable man" test to their activities--this is the standard of care they will be held to in a tort action. Finally, apply the safest driving environment possible within the resources available to you--and if you know of a hazardous or unsafe location which cannot be promptly repaired or corrected, get some warning signs out.

Other References

Attorneys involved in tort litigation frequently complain that highway officials and engineers do not work effectively with attorneys in preparing a case and that they often make poor witnesses. One of the references cited previously [13] includes the following sections with potentially useful information for engineers in preparation for resisting a tort claim:

- Liaison with Legal Staff
- Engineering Evidence
- The Engineer as a Witness
- Engineering Testimony
- Conduct When A Witness
- Engineer's Conduct Toward the Opposing Party.

Additionally, Baerwald [24], in a recent article specifically addresses the preparations for becoming an engineering witness in highway-related cases.

Three additional references deal with specific issues that are especially relevant to this research.

Liability of Traffic Officials in Illinois

Judge [25] deals with problems faced by counties as a result of claims growing out of alleged defects in roads and signs. Although the setting is Illinois, the legal basis for highway-related claims in Iowa is similar to that in Illinois and the problems are the same. Among the recommendations made in this paper are the following:

1. Each county should establish a road and sign inspection program. Although the author encourages use of a full-time inspector, he also sets forth suggestions for all employees of a county highway department, as follows:

   a. All County Highway Department employees are requested to note and inspect County Highway Department roads on their way to and from work. They are requested to take particular note for the following: (1) missing Stop signs; (2) missing Yield signs; (3) missing Stop Ahead signs; (4) missing "T" Intersection signs or intersectional signs; and (5) any defect in the road which they feel might cause an accident.

   b. Upon noting such a defect, the employee should immediately proceed to work and report such defect to the County Engineer, foreman, or crewman, unless the employee has the material to make temporary repairs.

   c. All employees, in driving to and from various jobsites in the course of the day, shall attempt, in their best judgement, to drive on the county road system looking for defects in the road or damaged or missing signs. Upon noting a defect or missing sign, they shall immediately report such problem. This shall be done only where reasonable and practical under the circumstances.

2. Cases against counties "should be resisted to the utmost. Payment of such cases only encourages additional lawsuits" whereas resistance

will make the prospect of suing a county unattractive to claimants. "Payments and lack of resistance to lawsuits only encourages plaintiffs to come back and take another cookie out of the cookie jar."

3. Coordination and cooperation with police officials should be encouraged. This includes not only investigation of accidents that could result in claims against the county but also timely notification of defective road conditions. "Police also should be advised only to report the facts in their report of accidents and not to surmise possible causes of accidents without sufficient facts to support the same."

4. A compaign should be carried out to inform the public about vandalism and stressing the need for reporting alleged defects in road or sign conditions. An advertisement to be placed in newspapers circulated within the county is proposed as follows:

> Safe driving and roads depend on everyone. Please help us keep your roads safe. Please report missing or damaged signs or other defect to your County Highway Department. Call _____ 24 hours a day. We try to serve. With your help we can.
>
> _____
> County Engineer

5. Records should be maintained with respect to roads and signs. Such records are useful in defense of tort cases where the alternative is to call upon employees or other witnesses for their recollections. Actual records are much more suitable as evidence.

6. A coordination of legal efforts is necessary. In some cases several attorneys may be involved, those representing one or more governmental entities and insurance company defense lawyers. Attorneys need to coordinate their efforts and put forth the same defenses.

Judge also includes a collection of thoughts on the investigation of road cases. This is reproduced in its entirety as Appendix A to this report.

Signs for Low Volume Rural Roads

Walton et al. [26] report the results of a study conducted by the Texas Transportation Institute for the Federal Highway Administration. The objective of the study was to evaluate the functional, economical, and esthetic applicability of the warrants and guidelines of the Manual on Uniform Traffic Control Devices (MUTCD) [27] for warning and regulatory signs and markings on low volume rural roads. Low volume roads were defined as those having an average traffic volume of fewer than 400 vehicles per day (vpd).

Generally, Walton et al. recommend use of standard signs on low volume rural roads in accordance with provisions of the MUTCD. This is the case unless the normal operating speed on the roadway is less than 40 mph, regardless of whether this lower speed results from the influences of "roadway geometrics, surface, environmental, or sight distance restrictions." Where speeds are lower than 40 mph, the report suggests use of signs such as those displayed in Figure 1, as appropriate. All of the signs in Figure 1 are to be 24 x 24 in. with black legend on a yellow background. An exception is made in the case of the Passing

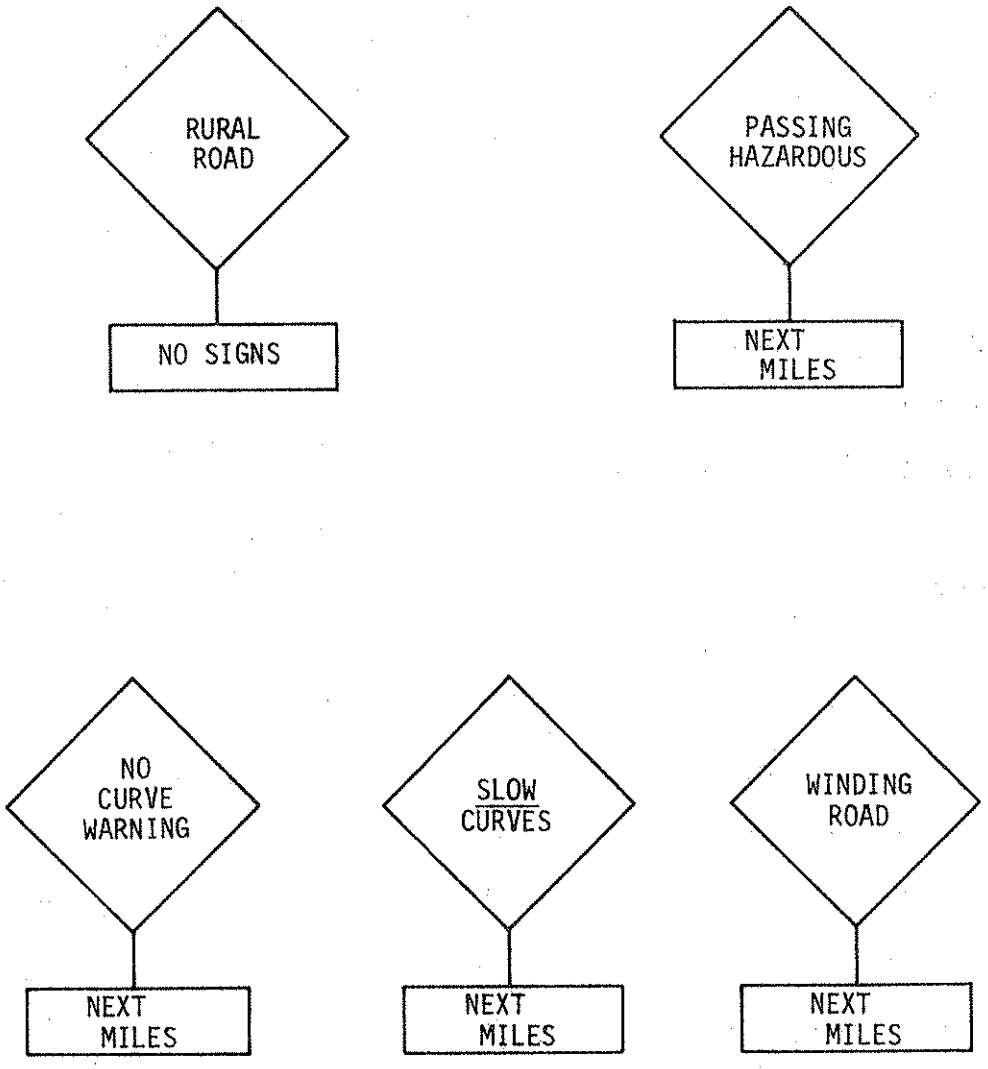


Figure 1. Special warning signs for low volume rural roads (source: [25]).

Hazardous sign which would be 24 x 24 in. where normal operating speeds are less than 40 mph but 30 x 30 in. for roads with normal operating speeds of 40 mph or greater. The other four signs are considered appropriate for use only where normal operating speeds are less than 40 mph.

Walton et al. also concluded that the use of advance warning signs on curves can be reduced from the level of usage suggested by the guidelines in the MUTCD without an appreciable decrease in safety. The suggestion is made that a standard curve warning sign be used where there is a differential of 10 mph or more between the normal approach speed and the safe curve speed. Where the speed differential is 15 mph or more, both a curve warning sign and an advisory speed plate are recommended.

A justification for stop control on low volume rural roads was developed in this study. The objective was to seek the lowest volume level at which operating costs and accident costs combined would be less with stop control than with no control. The resulting warrant is a function of vehicular volumes and approach speeds. Where operating speeds on all approaches are 55 mph (probably typical of intersections of paved highways in Iowa), a combined average daily traffic (ADT) on the two intersecting roads should be at least 710 vpd to justify stop control. If normal operating speeds are 45 mph on all approaches (typical of intersections of the better quality loose-surfaced roads in Iowa), a combined ADT of 670 vpd would warrant stop control. For other approach speeds, ADT requirements are as follows where the approach speed shown is for the intersecting roadway having the lowest speed:

Approach speed, mph	Combined ADT, vpd
20	300
30	500
40	640
50	700

The use of cross road warning signs is suggested by Walton et al. [26] at intersections with volumes less than those set forth above if sight distance is restricted. Sight distance criteria for this purpose are those set forth in the design policy of the American Association of State Highway and Transportation Officials for enabling vehicles to adjust speed [28]. These are as follows:

Approach speed, mph	Sight distance, ft
20	90
30	130
40	180
50	220
60	260

Distances shown above are used to define a triangle of clear visibility. The length of each side should be equal to or greater than the distance shown for the corresponding normal approach speed. Thus, if the sight distance is less than 200 ft on any approach at an intersection having normal approach speeds of 45 mph, and if stop control is not used, a cross road sign should be used on the approaches with inadequate sight distance triangles.

In respect to this report, it should be noted that the conclusions regarding warning signs were validated in the laboratory using test

subjects. There was no field validation. Use of the particular warning signs proposed would be consistent with the provisions of the MUTCD regarding warning signs for special conditions. However, there is no indication that these signs have been subjected to the very careful scrutiny occasioned by a trial in court to test the adequacy of warning that they afford. Decisions regarding their use must therefore be considered in that light.

Automobile Accident Litigation

Significant to this research are certain aspects of a study done by the Mitre Corporation for the Federal Judicial Center [29]. This study was undertaken on behalf of the U.S. Secretary of Transportation who was charged by the Congress to conduct a study of the automobile insurance and compensation system.

Several hypotheses concerning motor vehicle litigation were tested using a sample of 26 counties in 13 states (including two counties in Iowa). Although the study dealt with motor vehicle litigation in general, the findings are applicable to tort claims involving highway accidents as well.

Among the hypotheses tested and accepted was a finding that high jury awards, based on the median value of judgments, led to an increase in the proportion of accidents that resulted in lawsuits. The study confirmed that litigation was encouraged by a record of success as demonstrated by consistently large judgments in favor of plaintiffs.

It was also determined that cases commenced in trial before a jury tended to settle out before reaching a final verdict at a greater rate than trials before judges. The data gathered for this study indicated

that plaintiffs won cases more often than defendants and that jury trials resulted in larger judgments than trials before judges. Hence, a defense attorney tended to settle quickly when a jury case appeared to be going against the defendant.

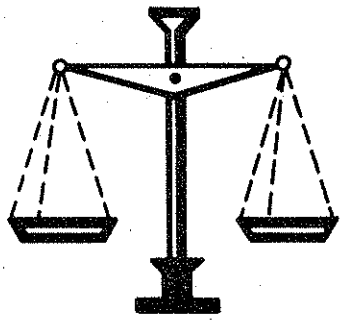
The results were inconclusive for a test of the hypothesis that cases terminated at or during trial showed larger dollar recoveries than those settled earlier. Although this appeared generally to be the case, the effect of a few high awards or settlements led to different results in some counties.

It was hypothesized that the number of persons served by each lawyer would have an effect on the number of cases that went to trial and on the proportion of accidents that resulted in filings. This hypothesis was not supported by the data. Nor was there a significant relationship between the concentration of accident cases among comparatively few attorneys and the number of cases reaching a verdict, the number of jury trials, or the dollar amounts recovered in accident cases.

III. SURVEY OF CLAIMS EXPERIENCE

Data Collection

The Survey Instrument



A survey of counties was undertaken in order to ascertain their experience concerning tort claims resulting from highway construction and maintenance activities. This was accomplished in part by mailed questionnaires sent to all counties in Iowa. The survey solicited information concerning any tort claims that resulted directly from each county's responsibility for constructing and maintaining highways (including use of traffic control devices). Any claims resulting from accidents involving county vehicles were not included in the survey unless the vehicle was involved directly in a construction or maintenance activity at the time of the accident.

The survey included any claims for which action was initiated during the period of January 1, 1973 to December 31, 1978. Any claim that was initiated prior to 1973 for which disposition was still pending was also to be included in the survey (however, none of these was reported).

The questionnaire was designed to obtain the following information about each claim:

1. Year the claim was initiated;
2. Dollar amount of the claim;
3. How the claim was disposed of; whether the claim ended in settlement, judgment, dismissal, or if the claim was still pending;

4. Year in which the settlement or judgment was determined; and

5. Specific allegation that afforded the basis for the claim.

Copies of the questionnaire and the accompanying cover letter are included in Appendix B.

Questionnaires were directed to County Engineers. It was also anticipated that County Attorneys would review and confirm the survey responses and they were requested to countersign the completed questionnaires. The questionnaire was mailed about November 21, 1978.

A follow-up letter was mailed to 50 County Engineers who had not responded by January 12, 1979. Each of 27 counties for which no response had been received by February 8, 1979 was subsequently contacted by telephone.

Similar Surveys by Others

Two surveys had recently been conducted by others to determine tort claim experience by counties. Both of these earlier surveys were useful in suggesting a format for the survey instrument used in this research. Responses to these surveys also afforded a check for the information returned on the questionnaires sent as part of this research.

One of these earlier surveys was directed to County Auditors by the Iowa State Association of Counties. This survey covered liability insurance but also solicited information concerning all claims on counties for the five years ending in 1977, including claims relating to highway maintenance. There were 86 responses to this survey.

The second survey was conducted by Milton Johnson, who was then President of the National Association of County Engineers. This survey covered the tort liability claims against county road departments and

had 61 responses from counties in Iowa. The questionnaire solicited responses concerning the number and dollar value of claims, settlements, and claims pending for the years 1973 through 1977.

Questionnaire Responses

Number of Responses

Eighty-five completed questionnaires were received. Sixteen respondents indicated that no applicable tort claims had been submitted to their counties during the period 1973 through 1978. Four of the five most populous counties in Iowa were among the 14 counties for which no completed questionnaire was received.

It became apparent during the course of this study that many County Engineers were unaware of the tort claims experience in their counties. Even more frequently, County Attorneys had no records of claims submitted to their counties. County Auditors had such information in some counties but not in others. Local representatives of the liability insurance carriers often had the most complete information if they had insured a county throughout the reporting period. Several County Engineers eventually became convinced that historical information on tort claims experience simply was not available for their counties.

Amount of Claims

The 85 counties responding to the survey reported total claims in the amount of $44,652,728 for the six-year period 1973 through 1978. Table 1 shows the annual amounts of claims and the proportion for each year of the average amount for the period 1973 through 1977. It may be

Table 1. Annual amounts of tort claims in 85 counties.

Year	Total amount, dollars	Proportion of 1973-1977 average
1973	6,342,008	1.007
1974	3,910,961	0.621
1975	8,338,906	1.324
1976	7,934,128	1.259
1977	4,973,057	0.789
1978	13,153,668	2.088
Total	44,652,728	

seen in Table 1 that the amounts claimed were relatively constant for the first five years of the reporting period. Claims submitted in 1978 were markedly higher, however.

Of the total claims from 85 counties during the period 1973 through 1978, $18,313,620 (41.0%) had been settled by the end of 1978 either through denial of the claim in its entirety, payment of the claim in whole or in part, or through a judgment imposed by a court. Payments amounted to $2,232,890, 12.2% of the amounts claimed in the cases settled. Claims pending at the end of 1978 amounted to $26,339,108 (59.0% of the total amount claimed during the six-year period). A summary of the claims experience by county is included in Table 2.

The total amount claimed resulted from 366 individual claims that were reported, an average of $122,002 per claim. Settlements were effected for 285 claims for which the average amount claimed was $64,258.

Table 2. Summary of highway-related tort claims by county.

County	Amounts in dollars 1973	1974	1975	1976	1977	1978	Total	Settled	Settlement	Pending
1 Adair	119	463	1,740	0	0	102,322	104,644	4,238	3,167	100,406
2 Adams	0	0	0	0	0	0	0	0	0	0
3 Allamakee	0	0	0	174,750	37,000	950	212,700	176,750	8,000	35,950
5 Audubon	0	0	9,300	375,000	0	500	384,800	9,800	1,700	375,000
6 Benton	0	0	0	0	0	475,000	475,000	0	0	475,000
8 Boone	0	6,172	226	14,823	0	639	21,860	21,560	7,023	300
9 Bremer	1,000	80,000	325,000	40,876	0	0	446,876	406,000	0	40,876
10 Buchanan	0	0	0	0	1,328,000	475,000	1,803,000	0	0	1,803,000
11 Buena Vista	550	708	2,462	400	0	687	4,807	4,707	4,007	100
12 Butler	0	0	0	0	0	0	0	0	0	0
13 Calhoun	0	0	0	1,750,000	0	0	1,750,000	0	0	1,750,000
14 Carroll	786	0	1,974	0	0	0	2,760	2,760	2,260	0
16 Cedar	0	0	483,625	0	0	751,045	1,234,670	483,624	0	751,046
17 Cerro Gordo	0	883	842	942	919	330	3,916	3,816	3,743	100
18 Cherokee	0	0	1,830	229	72	595	2,726	2,416	1,576	310
19 Chickasaw	0	0	0	277,928	250,000	0	527,928	277,928	5,000	250,000
20 Clarke	0	2,630	0	42,000	0	6,500	51,130	44,630	16,668	6,500
21 Clay	0	0	0	0	304,200	357,000	661,200	304,200	1,000	357,000
22 Clayton	0	0	2,995,000	0	0	0	2,995,000	2,790,000	875,000	205,000
23 Clinton	500,000	250,000	0	0	548	0	750,548	750,548	122,548	0
24 Crawford	0	25,200	1,620	300,000	0	14,000	340,820	26,820	1,153	314,000
25 Dallas	85,000	78,303	0	0	597,601	0	760,904	258,303	38,500	502,601
26 Davis	51,500	10,000	200,000	0	0	0	261,500	61,500	425	200,000
27 Decatur	0	0	0	525,000	0	2,000	527,000	525,000	160,000	2,000
28 Delaware	0	0	0	0	1,600	0	1,600	0	0	1,600
29 Des Moines	0	0	0	0	0	0	0	0	0	0
30 Dickinson	0	0	0	8,000	0	3,800,000	3,808,000	0	0	3,808,000
31 Dubuque	55,000	892,000	1,750,000	2,900,000	0	360,000	5,957,000	5,397,000	332,500	560,000
32 Emmet	0	0	0	33,600	0	0	33,600	0	0	33,600
33 Fayette	0	0	190,000	0	1,500	355,000	546,500	191,500	7,500	355,000
34 Floyd	100,000	0	0	0	0	0	100,000	0	0	100,000
35 Franklin	3,500,000	0	25,000	0	0	0	3,525,000	0	0	3,525,000
36 Fremont	50,000	0	0	5,000	0	0	55,000	55,000	1,000	0
37 Greene	500,000	0	0	0	0	0	500,000	0	0	500,000
38 Grundy	0	0	350,000	0	0	2,232	352,232	352,232	35,000	0
39 Guthrie	0	0	0	0	0	137,000	137,000	0	0	137,000
40 Hamilton	659	747	980	0	0	464	2,850	2,386	892	464
41 Hancock	0	0	0	7,000	500,000	0	507,000	7,000	0	500,000
44 Henry	0	2,375	332	319	4,200	700	8,126	8,126	5,051	0
45 Howard	0	0	0	0	0	0	0	0	0	0
46 Humboldt	0	0	0	0	0	0	0	0	0	0
47 Ida	0	32,050	0	0	0	0	32,050	32,050	0	0
49 Jackson	0	0	0	0	0	0	0	0	0	0
50 Jasper	0	0	0	0	888,450	1,350,000	2,238,450	0	0	2,238,450
51 Jefferson	0	181,320	0	0	0	1,161	182,481	182,481	1,161	0
53 Jones	0	0	0	35	67	350,300	350,402	402	402	350,000
54 Keokuk	0	0	0	265	175,000	624	175,889	175,889	0	0
56 Lee	46,700	2,045,000	373	128	1,755	633	2,094,589	2,092,834	454,834	1,755
58 Louisa	0	0	0	0	0	0	0	0	0	0

Table 2. Continued.

County	1973	1974	1975	1976	1977	1978	Total	Settled	Settlement	Pending
					Amounts in dollars					
59 Lucas	5,000	59	3,306	932	1,788	0	11,085	11,085	3,913	0
60 Lyon	0	0	0	0	0	0	0	0	0	0
61 Madison	0	0	0	316,800	100,870	0	417,670	198,870	16,870	218,800
63 Marion	0	0	0	0	0	0	0	0	0	0
64 Marshall	0	0	0	375	665	1,728	2,768	2,768	2,223	0
65 Mills	0	0	0	0	40	0	40	40	40	0
66 Mitchell	0	0	75,000	0	600,000	0	675,000	0	0	675,000
67 Monona	25,000	0	205,939	0	363	753,819	985,121	231,621	518	753,500
68 Monroe	0	0	0	0	0	0	0	0	0	0
69 Montgomery	4,765	145	440	101,100	0	0	106,450	106,450	8,385	0
70 Muscatine	0	0	0	343,244	0	0	343,244	0	0	343,244
71 O'Brien	1,364,663	0	0	0	0	0	1,364,663	1,364,663	0	0
72 Osceola	0	0	125,000	0	0	2,000,000	2,125,000	125,000	0	2,000,000
73 Page	0	0	0	0	50,000	8,955	58,955	0	0	58,955
74 Palo Alto	0	200	903,220	151,387	43,149	0	1,097,956	155,410	17,509	942,546
75 Plymouth	0	0	0	0	0	0	0	0	0	0
76 Pocahontas	628	0	320	360	1,234	0	2,542	2,542	2,542	0
78 Pottawattamie	5,070	4,525	2,373	1,000	29,303	263,074	305,345	283,845	9,949	21,500
79 Poweshiek	0	0	0	0	0	0	0	0	0	0
80 Ringgold	0	0	117	985	208	126	1,436	1,436	1,436	0
81 Sac	45,568	0	0	0	30,000	0	75,568	45,568	0	30,000
82 Scott	0	295,000	170,000	0	0	0	465,000	295,000	55,000	170,000
83 Shelby	0	0	33	20,000	0	4,025	24,058	2,033	797	22,025
84 Sioux	0	0	250,000	0	0	0	250,000	250,000	2,000	0
85 Story	0	82	150,802	0	22,550	2,259	175,693	2,213	0	173,480
86 Tama	0	0	0	0	0	25,000	25,000	0	0	25,000
87 Taylor	0	0	0	0	0	0	0	0	0	0
88 Union	0	3,099	0	0	0	0	3,099	3,099	3,099	0
89 Van Buren	0	0	0	0	0	50,000	50,000	0	0	50,000
90 Wapello	0	0	0	0	0	1,500,000	1,500,000	0	0	1,500,000
92 Washington	0	0	0	0	0	0	0	0	0	0
93 Wayne	0	0	0	0	0	0	0	0	0	0
94 Webster	0	0	0	0	0	0	0	0	0	0
95 Winnebego	0	0	36,729	0	0	0	36,729	36,729	3,000	0
96 Winneshiek	0	0	323	1,450	1,975	0	3,748	3,748	2,999	0
98 Worth	0	0	75,000	540,000	0	0	615,000	540,000	12,500	75,000
Totals	6,342,008	3,910,961	8,338,906	7,934,128	4,973,057	13,153,668	44,652,728	18,313,620	2,232,890	26,339,108

The average settlement or judgment was $7,835. Eight-one claims were reported to be pending, an average of $325,174 per outstanding claim.

A brief comment is in order concerning the accuracy of the information obtained from survey responses. Research personnel believe that the claims amounts reported are less, by some unknown amount, than the actual amounts claimed. Reasons for this belief include the following:

1. Some claims that were significant enough to be reported in newspapers or were otherwise known to research personnel were not included.
2. Some significant claims were mentioned by county engineers during interviews but had not been reported on the questionnaires as part of their claims experience.
3. Several counties reported only larger claims although numerous comparatively small claims constituted the bulk of the claims experience of many counties.

Some claims using reasons 1 and 2 above were added to the appropriate questionnaires if sufficient information concerning the claims could be obtained. However, the frequency of occurrence of these omissions led to a conclusion that tort claims had been underreported, although it is not possible to estimate the extent of such underreporting.

Experience by Causative Factors

In order to identify the problems underlying highway-related tort claims, those reported by the 85 counties responding to the survey have been grouped by causative factors. The summary of amounts by categories is displayed in Table 3. Table 4 indicates the amounts of settlements by claims categories. Shown in Table 5 is a summary of the amounts for

Table 3. Ranking of categories by total dollar amount of claims.

Category	Total Claims (Dollars)	Number of Claims	Average Claim (Dollars)
Inadequate shoulder	7,996,540	17	468,620
Improper signing of curve	7,622,843	12	635,237
Railroad crossing sign	5,780,607	12	481,717
Uncontrolled intersection	4,930,251	10	493,025
T intersection	3,822,165	17	244,833
Rough road	2,825,275	39	72,443
Roadway geometric deficiency	2,120,568	4	530,142
Snow or ice on road	1,462,000	10	146,200
Improper signing for road closure	1,375,661	8	171,958
Mud on road	1,350,000	4	337,500
Bridges	974,391	19	51,284
Improper sign placement	882,938	11	80,267
Gravel windrow and loose gravel	782,444	32	24,451
County vehicle accidents	766,841	114	6,727
Construction signing	611,048	10	61,105
Narrow road	470,845	4	117,711
Water backup or right-of way encroachment	145,987	8	18,248
Road washouts	110,023	4	27,506
Other maintenance activities	17,301	28	618
Unclassified	635,000	3	211,667
Total	44,652,728	366	122,002

Table 4. Ranking of categories by total dollar amount of settlement.

Category	Total Settlements (Dollars)	Number of Settlements	Average per Settlement (Dollars)	Amount of Original Claims (Dollars)	Settlement Cost as Percent of Claims
Improper signing of curve	997,418	8	124,677	3,692,297	27
Inadequate shoulder	610,700	9	67,856	5,280,040	12
Railroad crossing sign	236,000	8	29,500	1,555,607	15
Improper signing for road closure	116,683	7	16,669	1,000,661	12
Rough road	58,842	28	2,102	426,272	14
T intersection	50,264	7	7,181	289,389	17
County vehicle accidents	45,798	108	424	442,481	10
Snow or ice on road	45,000	5	9,000	693,500	6
Gravel windrow and loose gravel	30,588	28	1,092	669,480	5
Construction signing	10,439	8	1,035	61,048	17
Road washouts	6,600	4	1,650	110,023	6
Improper sign placement	6,244	5	1,249	359,261	2
Other maintenance activities	6,076	24	253	12,976	47
Water backup or right-of-way encroachment	6,020	8	752	145,987	4
Bridges	4,843	16	303	254,391	2
Uncontrolled intersection	1,000	1	1,000	4,200	24
Narrow road	375	2	188	210,439	0
Mud on road	0	4	0	1,350,000	0
Roadway geometric deficiency	0	3	0	1,220,568	0
Unclassified	0	2	0	535,000	0
Total	2,232,890	285	7,835	18,313,620	12

Table 5. Ranking of categories by total dollar amount of claims pending.

Category	Total Pending (Dollars)	Number of Claims Pending	Average per Claim Pending (Dollars)
Uncontrolled intersection	4,926,051	9	547,339
Railroad crossing sign	4,225,000	4	1,056,250
Improper signing of curve	3,930,546	4	982,636
T intersection	3,532,776	10	353,278
Inadequate shoulder	2,686,500	8	335,813
Rough road	2,399,003	11	218,091
Roadway geometric deficiency	900,000	1	900,000
Snow or ice on road	768,500	5	153,700
Bridges	720,000	3	240,000
Construction signing	550,000	2	275,000
Improper sign placement	523,677	6	87,280
Improper signing for road closure	375,000	1	375,000
County vehicle accidents	324,360	6	54,060
Narrow road	260,406	2	130,203
Gravel windrow and loose gravel	112,964	4	28,241
Other maintenance activities	4,325	4	1,081
Unclassified	100,000	1	100,000
All other categories	0	0	0
Total	26,339,108	81	325,174

the claims that were pending at the end of 1978, also by categories. The numbers of claims filed, settled, and pending as well as average amounts are also shown in Tables 3, 4, and 5.

A description of typical incidents that were included in each claims category is in the following section. However, it should be noted that an attorney for a plaintiff typically will employ a "shotgun" approach in preparing a case against a county defendant. The allegations often will include a wide variety of imperfections in signing and roadway geometrics. In such cases, the category has been selected that appears to be most relevant to the particular incident that gave rise to a claim.

Description of Claims Categories

Inadequate Shoulder

Shoulder inadequacies reported by the counties as leading to tort claims were about equally divided between dropoffs at a pavement edge and other deficiencies. Dropoffs involved in such cases allegedly ranged from 3 to 12 in. Other problems included locations where the shoulder allegedly was soft, some material had eroded, or the shoulder otherwise was deficient in an unspecified manner.

Three of the incidents resulting in claims in this category led to demands in excess of $1,000,000. This category tends to be among the more costly in terms of average settlement per claim as well as in the amount demanded per claim. Three of the nine cases that had been settled resulted in no payment to the claimants.

Improper Signing of Curve

Allegations of improper signing of curves have tended to be general in nature simply specifying a failure to provide adequate warning. In many instances, deficiencies in the design of a roadway have been alleged, as well as imperfections in signing.

Claimants generally have referred to the MUTCD [27] as the appropriate authority for signing practices. Depending upon the signing actually in place, the alleged negligence might involve failure to use an advisory speed plate, a large arrow (or chevron) sign, or both.

Claims and settlements in this category have tended to be quite large. Four of the claims have been for amounts in excess of $1,000,000 and one case tried before a jury resulted in a judgment of $875,000 against the county. Three of the eight cases in this category that had been settled resulted in no payment to the claimants.

Railroad Crossing Sign

The usual allegation for claims in this category has been that a county was negligent in failing to erect a stop sign or automatic signals at a railroad grade crossing. Impetus for these claims was afforded by Section 321.342, Code of Iowa [1], which suggested the appropriateness of stop signs at "particularly dangerous" crossings. However, a different basis has been stated for the largest claim reported (for $3,500,000). Failure to install lights at the crossing is cited in this case to support an allegation of negligence by the county.

Average amounts claimed in this category have tended to be quite large. Four claims were for amounts of $500,000 or more. Of eight claims in this category that had been settled, two claims for

comparatively small amounts were settled with no payment to the claimants. The other settlements resulted in consequential payments by the counties.

Uncontrolled Intersections

Claims in this category have involved allegations that counties were negligent in failing to provide stop control at intersections. If two-way stop control had been provided, a need for four-way stop control will have been alleged. Such claims may also have been accompanied by assertions that other problems existed such as deficiencies in the designs of the intersecting roadways. On paved highways, some claims have also alleged a need for rumble strips.

Only one small claim in this category had been settled. The other nine claims were pending at the end of 1978. All of these demanded $200,000 or more in damages.

T Intersection

Most of the claims in this category have involved alleged deficiencies in the signing needed to provide sufficient warning at T intersections. An advance warning sign, or a large arrow sign on the far side of an intersection, or both have most frequently been at issue. However, both of the claims in this category for over $1,000,000 resulted from accidents at stop-controlled T intersections. The reflective quality of the stop sign was at issue in both cases.

Claims in this category have varied widely from relatively small amounts for vehicle damages to very large amounts when serious personal injury resulted. Seven claims in this category had been settled with payments ranging up to $33,500, although four settlements resulted in no payment to the claimants.

Rough Road

Claims for several forms of alleged road surface deficiencies have been included in this category. In many instances the claim merely was that the road was rough. Frost boils on loose-surfaced roads have supplied the basis for some of these allegations. Potholes have frequently been alleged. Blowups on portland cement concrete pavements have afforded yet another basis for claims.

Many of the cliams in this category have been for small amounts to cover vehicle damage only. However, two claims demanded $500,000 or more. Many small claims have been settled for the amount requested, although about a third of the 28 claims for which settlement had been reached resulted in no payment to the claimants.

Roadway Geometric Deficiency

This category* includes four claims that have alleged the following specific deficiencies in roadway design:

- Excessively steep grade
- Inadequate sight distance on a curve
- Excessive crown on a road.

Claims in this category generally have been for substantial amounts. The two claims alleging excessive gradients demanded $1,000,000 and $900,000, respectively. The latter case was pending at the end of 1978, but the other three claims in this category had been settled without payment to the claimants.

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*Note that allegations involving the width of a roadway have been included in a separate category on narrow roads (see p. 40).

Snow or Ice on Road

Claims in this category have resulted from accidents allegedly caused because snow or ice was on the roadway. Counties in these cases allegedly were negligent either for failure to remove snowdrifts or by failing to correct slippery conditions caused by ice or packed snow.

Most of these claims arose due to snow or ice accumulations from precipitation. All of the claims of this nature that had been settled resulted in no payment to the claimants. The one case that has resulted in payments to several claimants came about because ice had accumulated on the roadway due to runoff from adjacent land.

Improper Signing for Road Closure

Of eight claims in this category, four were for minor damage that occurred when automobiles or light trucks struck part of the signing or barricades used to close a road. Another claim for $375,000 arose when a motorcycle struck a barricade closing a road. The barricade allegedly did not conform with standards.

The other three cases, claiming amounts from $150,000 to $500,000, arose because a road allegedly should have been closed but it was not. Each of these cases was settled with significant payments to the claimants. In two instances, a bridge had washed out and in the other case some construction activity was taking place.

Mud on Road

The four claims in this category resulted from the same incident. A vehicle traveling on a paved county highway encountered a road section that was slippery due to the presence of mud and skidded out of control. A jury trial resulted in a verdict in favor of the defendant county.

Bridges

Most claims in this category have been small demands to cover vehicle damage. They generally resulted from roughness of the deck, often a timber deck. However, four claims, as follows, have been substantial:

- $300,000 because a bridge deck allegedly was slick from frost,
- $250,000 for a collapse under the load of a truck,
- $250,000 for an accident allegedly resulting from loss of control due to a dip in the bridge approach (settled for $2,000),
- $170,000 for an approach fill that was undermined and gave way beneath a vehicle.

Three of these four claims were pending at the end of 1978.

Improper Sign Placement

This category was included to encompass alleged signing deficiencies not included in the categories involving curves, railroad crossings, T intersections, road closures, or construction activities. Most such claims have involved stop signs that either were obstructed or were missing as a result of vandalism.

Among other claims, the largest (for $350,000) alleged failure to install a pedestrian crossing sign. One claim resulted because no advance warning sign was used preceding a stop. Another alleged that a county was negligent because of no-passing zone had not been established. Claims in this category that had been settled generally resulted in small payments to the claimants.

Gravel Windrow and Loose Gravel

Most of these claims have involved vehicle damage only, although a few involved accidents with personal injuries. They resulted when a vehicle either 1) struck the gravel windrow that occurred during blading of a loose-surfaced road, or 2) encountered loose gravel that allegedly had not been sufficiently spread, or 3) hit a large stone lying on the road. Most claims of this nature had been settled by paying the claimant most or all of the amount claimed.

Three such claims have been for amounts of $100,000 or more. All of these were settled without payment to the claimant. (Although one was pending at the end of 1978, it was settled subsequently by a jury trial that found for the defendant county.) One claim of a different nature in this category resulted in a jury award to the plaintiff. In this case, crushed stone from the shoulder had encroached onto the edge of the pavement causing loss of control of a vehicle on a curve.

County Vehicle Accidents

Claims resulting from motor vehicle accidents were not included in the responses to the survey unless they occurred when a county vehicle was actually engaged in a construction or maintenance activity. Consequently, most of the claims in this category resulted from accidents involving graders or snow plows. Fewer of the accidents giving rise to these claims involved trucks, mowers, or heavy equipment. Included are accidents resulting in damage to other vehicles as well as to other types of property.

Relatively few of these accidents resulted in personal injuries. Consequently, claims and settlements have tended generally to be small.

However, three larger claims were among those pending at the end of 1978. Each involved a county vehicle that was parked (trucks in two cases, a grader in the other) when struck by a claimant's vehicle. These three claims were for a total of $323,000.

Construction Signing

This category includes claims resulting from alleged deficiencies in warning of construction or maintenance (other than routine blading) activities on the road. Note that claims involving signing for road closure have been included in a separate category and previously discussed (see p. 37).

The largest claim (for $500,000) resulted when a workman sealing cracks on a resurfacing project was struck by a passing automobile. Three claims involved vehicles running into excavations. Other claims resulted from accidents involving an automobile that struck a bituminous paving machine, a motorcycle that skidded on a bridge deck after it was treated with linseed oil, and an automobile that struck the end of a culvert pipe lying on the shoulder.

Narrow Road

Four claims were placed in this category. Two resulted from accidents on roads that allegedly had become too narrow due to erosion of one edge of the road. One of these, demanding over $205,000, was occasioned when a farm tractor rolled into the ditch killing the operator. A jury trial of this case resulted in a verdict in favor of the defendant county.

The other two cases apparently involved roads that had retained their design widths. One pending claim, for $250,000, was occasioned by an accident on a bridge that was 20 ft wide. The other pending claim followed an accident on a dirt road that allegedly was too narrow for two vehicles to meet safely.

Water Backup or Right-of-Way Encroachment

This category includes claims arising from highway construction or maintenance activities that in some manner interfered with the property rights of adjacent land owners. In four cases, construction of a drainage facility allegedly caused water to back up on adjacent land. In two cases, trees on private property were cut down without the owner's consent. The other two cases involved encroachment of a roadway onto private property. The settlement in one such case required that the county move the road.

Road Washouts

In each of these four claims, a road allegedly had washed out causing an accident that gave rise to the claim. It may be noted that some of the claims involving shoulder deficiencies, road closure signing problems, and narrow roads also involved erosion of some part of a roadway. Claims in this category differ, in that each incident affected the traveled portion of the road and the principal allegations concerned warning of a hazard rather than road closure.

Three of the claims were settled without payment to the claimants. The fourth case resulted in payment of $6,600 to settle a claim of $101,000.

Other Maintenance Activities

This category has involved only comparatively small claims and includes the following bases for claims:

- Gravel blowing from trucks and damaging passing or following vehicles,
- Farm gates left open by county employees,
- Damages to crops or other vegetation on private property from weed spraying,
- Damages resulting from tree trimming by county crews,
- Other types of property damages resulting directly from road maintenance activities.

Claims in this category generally have been settled by the insurance carriers. Only three of 24 claims that had been settled resulted in no payment to the claimants.

Unclassified

Three sizable claims could not be included in other claims categories. These are as follows:

- $325,000 for a work area accident involving a fatal injury to a contractor's employee. This claim was apparently settled without cost to the county.
- $210,000 following a house fire. Access by fire equipment was hampered because the county had a bridge under repair. This case was tried in court with a verdict in favor of the defendant county.
- $100,000 arising from a collision between an automobile and a post placed on the road shoulder to support a box used for newspaper delivery. This claim was pending at the end of 1978.

Summary of Findings

Amount of Claims

A total of $44,652,728 in highway-related tort claims was reported by 85 counties for the period 1973 through 1978. Of this total, $26,339,108 in claims had not been settled at the end of 1978.

Using the average of over $525,000 per county, the survey results suggest that a statewide total for 99 counties would exceed $52,000,000 in total claims. A similar calculation for pending claims indicates that over $30,000,000 in claims was pending for all 99 counties.

Settlements of claims submitted during 1973 through 1978 were effected at a cost to the counties or their insurers of $2,232,890. This was 12.2% of the amount claimed in these cases. It must be noted that these figures do not include costs for processing of claims, any legal costs, or court costs.

Annual claims figures do not support a hypothesis that highway-related tort claims are increasing from year to year. No trend is evident from the claims totals for the period 1973 through 1977. However, claims submitted during 1978 amounted to over twice the annual average for the preceding five-year period. It is not apparent whether the 1978 claims experience was the start of a new trend or whether it was merely a statistical aberration in a time series that otherwise was relatively flat.

Claims Categories

Approximately 56% of the highway-related claims submitted to 85 counties during the period 1973 through 1978 related directly to traffic

control and signing practices. An additional 40% related to roadway deficiencies of such nature that the lack of adequate warning could support an allegation of negligence against a county. Thus, proper signing practices can afford at least a partial defense against 96% of all claims.

Comparable figures for settlements during the period were 64% relating directly to traffic control and 34% relating to other deficiencies requiring warning.

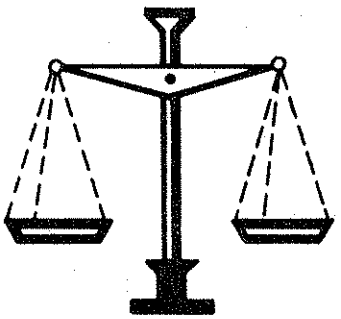
Table 3 indicates the claims categories that represent the greatest exposure to highway-related tort claims, based on six years of data from 85 counties in Iowa. It may be seen that 67% of the claims occurred in only five claims categories.

It is also useful to compare the amounts claimed in Table 3 with the amounts of settlements in Table 4. Some claims categories appear to afford a relatively high probability of recovery, while others have not been fruitful for claimants. For example, payments of $997,418 have been required to satisfy $3,692,297 in claims for improper signing on curves, a payout of 27%. It should be noted, however, that $875,000 of this amount resulted from a single adverse judgment. On the other hand, roadway geometric deficiencies have garnered no payments for claims totalling $1,220,568.

Some claims categories are relatively new arrivals on the tort claims scene in Iowa. Historical experience is not available with which to evaluate the potential financial loss to counties from these claims. An example is the category of uncontrolled intersections, the category with the largest amount of claims pending at the end of 1978. There

was no report by any county of such a case recently having been adjudicated in court in Iowa. Even though the potential exposure is high, the amount that will be required to satisfy such claims can not be estimated from past experience.

IV. INTERVIEWS WITH COUNTY ENGINEERS



Information included in responses to mailed questionnaires constituted the primary source of factual input to this research. Supplemental information was afforded through interviews with several County Engineers. The principal objectives of these interviews were to increase the understanding by research personnel of some of the problems indicated by the survey and to seek out other problem areas that were of concern to County Engineers but were not evident from the questionnaire responses.

Conduct of Interviews

Personal interviews were conducted with 11 County Engineers. Counties for these interviews were selected to cover as many as possible of the tort claim problem types, as indicated by questionnaire responses. The counties were also selected to afford coverage of geographically dispersed areas of the state. Interviews were held with Engineers representing the following counties:

Cedar	Dickinson	Osceola
Chickasaw	Floyd	Pottawattamie
Clinton	Keokuk	Shelby
Dallas	Madison	

Each interview lasted from two to three hours.

Interviews in some depth were also conducted by telephone with County Engineers in Des Moines and Lyon Counties. Discussions were held, in their offices, with Engineers in Franklin and Story Counties who had completed a preliminary version of the survey instrument that was used to develop the final form of the mailed questionnaire. Additional telephone contacts were made with about 25 other County Engineers for more limited discussions, generally in order to clarify or expand upon information furnished in their questionnaire responses.

Although the interviews were relatively unstructured, the following topics were discussed in most instances:

- Claims reported on the questionnaire responses,
- Procedures for maintaining loose-surfaced and unsurfaced roads,
- Policies regarding coordination of efforts on county line roads,
- Policies covering use of stop control,
- Use of speed limits outside cities,
- Use of lighting at rural intersections,
- Practice in respect to accident reporting,
- Sign inventory,
- Signing practice in respect to T intersections, and
- Use of advisory speed plates.

Summary of Findings

Most County Engineers, based on their interview responses, usually were informed when a highway-related tort claim had been filed against their county. They often played important roles in investigating the

incidents giving rise to claims. However, settlements were often effected without the Engineers being aware of the intermediate negotiations or the final disposition of claims.

Routine Maintenance of Loose-Surfaced and Unsurfaced Roads

Each county for which the Engineer was interviewed was divided into maintenance districts for routine blading and snow removal on loose-surfaced roads. A grader with operator was assigned to each district. Data from 14 counties indicated a range from 7 to 21 with an average of 11.4 graders per county.

Most graders in outlying districts were located at maintenance sheds when not in use, generally within the district although often in an adjacent district. However, machines were stored outside in the weather in several districts in some counties.

Graders normally worked singly and covered most roads in their districts in four- or five-day cycles. It was not uncommon for a grader to work in a lane in the direction opposite to the normal flow of traffic.

Private citizens reportedly often complained when they observed graders moving at travel speed to or from working locations with their blades raised (deadheading). Thus, there appeared to be a tendency on the part of most operators to work road sections that were not in particular need of work in order to avoid triggering complaints. This occurred when a grader was in the process of moving to a location where its efforts would be more productive. Such a response necessarily occasioned some sacrifice in efficiency.

Operators normally made a permanent record of the roads covered during each day. They also were afforded an opportunity to record other

events or problems. Two-way radios have been installed in graders in some counties.

Each County Engineer interviewed was convinced that there was no alternative method of operation of graders in routine maintenance that could improve safety without inducing an intolerable sacrifice in the efficiency of utilization of manpower and equipment.

Coordination at County Line Roads

Approaches to coordination of maintenance activities on county line roads varied widely among the counties in which interviews were conducted. Similar problems were also reported at state lines and municipal corporation boundaries.

Formal agreements approved by resolutions of the Boards of Supervisors were in effect for some counties. Informal agreements between County Engineers were more common, however. Agreements always covered routine maintenance operations such as blading, snow removal, and mowing. Responsibility for signing was less frequently spelled out in such agreements.

Several examples were noted of potentially serious discrepancies or omissions in traffic control on county line roads. Most of these involved differing policies between counties that occasioned inconsistencies in respect to stop control.

Stop Control

Counties most frequently utilized stop control to afford preferential treatment to through highways. Thus, lesser roads were normally caused to stop at approaches to paved highways and other roads on the trunk

system. Some counties also protected roads on the farm-to-market system by using stop signs on sideroad approaches.

Other stop sign installations were based on studies by the County Engineers, generally more informal than formal, that considered traffic volumes, sight distances, accident experience, composition of the traffic streams, and other factors as appropriate. Many such studies were initiated in response to suggestions from private citizens. If need for a stop sign was indicated, a recommendation would be made to the Board of Supervisors. The sign would then be installed following a resolution by the Board.

All of the County Engineers interviewed spoke of the generally low level of obedience to stop signs at rural intersections. They were aware of the adverse effect on safety that could result from an excessive use of stop signs. (This factor is pointed out in Section 2B-5 of the MUTCD [27] which cautions against the indiscriminate use of stop signs.) County Engineers were particularly troubled by the outcome of some recent court cases that seemed to suggest need for stop signs at railroad grade crossings with very low volumes of trains and highway vehicles and with no sight-distance restrictions.

Several County Engineers reported that they had on occasion updated the legal authority for all stop signs by obtaining passage of a blanket resolution. Such a resolution would cover all of the stop signs installed in the county or a portion thereof on the effective date of the resolution. Other counties reportedly were operating under a County Attorney's opinion that such blanket resolutions were without legal basis.

Speed Limits

The only instances of speed limits on county roads reported by the County Engineers who were interviewed were in built-up areas. These included roads in incorporated communities, unincorporated communities, and rural subdivisions. Speed limits were implemented on the basis of traffic engineering studies carried out by personnel of the Iowa Department of Transportation.

Most of the County Engineers who were interviewed stated that they would not favor the passage of legislation that would impose a limit lower than 55 mph for travel on loose-surfaced or unsurfaced county roads.

Roadway Lighting

Practices among counties varied widely in respect to the use of roadway lighting. Lighting was not used on county road systems in a majority of the counties visited. Usage in four counties that had installed lights varied from 6 to 27 locations. Most installations consisted of a single luminaire at an intersection. Two lights were used at a few locations.

Economic constraints were apparently only one reason for not using more lights at county road intersections. Some County Engineers saw no need for fixed lighting. Others viewed lights as only another problem area in attracting vandalism. Several also cited instances where nearby residents had objected to the glare from fixed lighting.

Accident Reporting

Eight of the 14 County Engineers with whom this topic was discussed indicated that they seldom or never were notified of an accident on a

county road that was investigated by the Sheriff's Office. Four others stated that they were usually notified and two felt that they were made aware of virtually all accidents investigated by the sheriff. In no case could a County Engineer anticipate notification of an accident if the investigating officer was from the State Patrol. There is no other mechanism for timely notification of County Engineers of accidents that may result in tort claims against counties.

Sign Inventory

Each County Engineer interviewed reported the existence of some form of sign inventory for his county. These varied widely in complexity and format. Most inventories consisted of a series of maps, each usually covering a single township, on which signs were located. Some detail as to sign type and condition was afforded by a symbol, number, or series of numbers on the maps. Other inventories were on cards or forms prepared for this purpose. One county was in the process of implementing a computerized sign inventory.

The most common procedure for updating an inventory was a semiannual or annual visual inspection of signs on the entire county highway system by a person designated to have primary responsibility for signing. Some systems, particularly the computerized system, were designed to permit continuous updating. Some counties seem not to have updated their inventories for several years.

Most counties have one or two persons assigned nearly full time to signing with responsibilities for inventories, installation, and repairs.

Warning Signs

Philosophies regarding sign usage varied widely among the County Engineers who were interviewed. These differences were manifested most clearly in respect to the use of warning signs. About half of these Engineers favored adherence to the minimum requirements set forth in the MUTCD [27]. The others clearly went beyond these minimum requirements in varying degrees by using more warning signs than strict adherence to the MUTCD would suggest.

County Engineers at each end of this spectrum made convincing arguments to support their points of view. At the one extreme is the feeling that an increased use of warning signs would tend to lull motorists into a false sense of security. This, in turn, would lead to a failure to be sufficiently alert to the hazards inherent in travel on any highway, particularly one possessing the characteristics of a typical county road in Iowa. Advocates of the opposite point of view stressed the desirability of guiding and warning motorists continuously to afford them with positive guidance. The highway agency thus assumed a portion of the responsibility for the driving task.

Counties generally exhibited pronounced differences in the elaborateness of signing depending upon the highway type. Advance warning signs of all types tended to be used much more frequently on paved roads with high volumes than on unpaved roads carrying very low traffic volumes.

Sign installations for T intersections, as an example, were usually more elaborate on paved roads. Both an advance warning sign (stop ahead or T intersection) and a large arrow sign on the far side of the

intersection were common on paved highways. One or both of these signs was more likely to be omitted on unpaved roads.

Similarly, advisory speed signs were rarely reported on unpaved roads by the interview responses. Their use was much more common on paved highways. The appropriate advisory speed generally was determined by trial runs to determine a speed that precludes sliding and feels comfortable. A ball bank indicator reportedly was used to assist in this process by only two of the County Engineers who were interviewed.

Vandalism of Traffic Control Devices

A critical concern for vandalism of traffic signs and hazard markers was expressed by all of the County Engineers who were interviewed. Loss of these devices not only has occasioned a substantial expense to the counties for replacement but also has been the proximate cause of a number of accidents and led to several tort claims.

The use of a traffic control device as a target for firearms has been the most common form of vandalism. Most traffic signs in rural areas, especially those in more isolated locations, have needed to be replaced substantially short of their expected service lives due to this type of damage. Also common was the form of rampage in which dozens of signs in a single night would fall prey to vandals using chain saws or four-wheel-drive vehicles.

It is difficult to formulate an appropriate response to the destruction of traffic signs, according to the County Engineers who were interviewed. Some County Engineers have reported success with information campaigns that made an appeal to the public and pointed out the hazards and expense occasioned by vandalism of signs. Others have found

such campaigns counter-productive. Directing attention to the problem apparently attracted more imitators than it deterred.

Similar experience was reported ragarding vigorous prosecution and punishment of those apprehended after destroying traffic signs. The rather nominal fines received by offenders and the resultant publicity was often believed to lead to more sign destruction and to have no deterrent effect. A majority of the County Engineers who were interviewed preferred to maintain a low profile regarding the destruction of traffic control devices rather than to publicize the problem. Unfortunately, the problem of vandalism appeared clearly to the interviewers to inhibit the more extensive use of warning signs. County Engineers generally desired to minimize their exposure to vandalism by reducing the number of signs.

Additional Comments

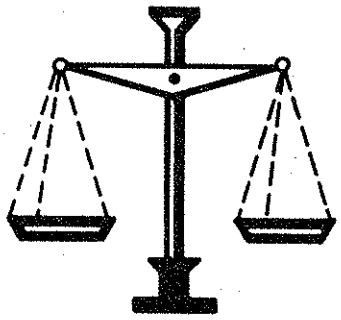
A number of County Engineers reported problems with routine tasks that required a level of traffic engineering expertise not normally available to counties. An example was the marking of no-passing zones, a fairly complex undertaking that can best be accomplished by a trained crew of traffic engineering technicians using specialized equipment. The determination of advisory speeds on curves is another example of a task requiring specialized training that is rarely found at the county level in Iowa. Signing of construction work sites was also mentioned as an area of concern. Construction signing imposes demands for traffic engineering expertise that are difficult for counties to satisfy and involves an inordinate potential for accidents and claims.

Some County Engineers expressed concern with problems of providing for the passage of very wide items of farm equipment over narrow bridges on county roads. These wide loads have proven to be incompatible with various safety appurtenances including hazard markers, guard rails, and improved bridge railings.

Most of the County Engineers who were interviewed regularly investigated accidents that occurred on county roads and were reported to them. They documented the facts relating to possible causes of the accidents including measurements of marks left by the vehicle or vehicles involved. They also took photographs of road conditions and control devices. Several instances were reported where photographs taken by a County Engineer immediately following an accident were the critical items of evidence in sustaining the denial of a tort claim that had been based on erroneous facts.

V. ANALYSES AND SUPPLEMENTAL STUDIES

Statistical Analysis of Tort Claims Experience



A regression analysis of the six-year tort claims experience by county was undertaken. The objective of this analysis was to identify any demographic or geographic factors that tended significantly to explain the variation in claims experience among counties.

The independent variables used in this analysis are listed in Table 6. The dependent variable was the total amount of claims reported for a county during the period 1973 through 1978. Similar analyses were also carried out using the dependent variable claims per capita.

To help assure that spurious relationships were eliminated, the following criteria were established for evaluation of an equation.

1. A regression coefficient was to have a t-value of at least 2.00, indicating a probability of at least 0.95 that it did not occur by chance.
2. A regression coefficient was to have the same sign as the correlation between that independent variable and the dependent variable. (A correlation matrix for this analysis is presented in Table 7.)

All of the equations that were developed had very low explanatory capabilities. The best equation satisfying the above criteria is as

Table 6. Definition of dependent and independent variables.

Variable	Definition
CLAIM	Total dollar amount of claims for a county from 1973 through 1978
LAT	Latitude of the county seat of a county, minus 40 deg
LONG	Longitude of the county seat of a county, minus 90 deg
POP	County population based on the 1970 census
LSRD	Miles of loose-surfaced and unsurfaced roads in a county's secondary road system (1977)
HSRD	Miles of hard-surface roads in a county's secondary road system (1977)
TOTRD	Total road mileage in a county's secondary road system (1977)
LAW	Number of attorneys in a county that are members of the Iowa State Bar Association (1978)
VEHMI	Vehicle-miles traveled per day on a county's secondary road system (1977)
LAND	Average value in dollars per acre of agricultural land in a county (1978)
URBAN	Population in county residing in communities of at least 1,500 (1970)
RURAL	Population in county residing outside communities of 1,500 or more (1970)

Table 7. Correlation coefficients and mean values for variables in regression model.

	CLIAM	LAT	LONG	POP	LSRD	HSRD	TOTRD	LAW	VEHMI	LAND	URBAN	RURAL
CLAIM	1.00	0.215	-0.153	0.244	-0.034	0.093	0.002	0.195	0.206	0.091	0.214	0.317
LAT		1.00	0.121	-0.039	0.127	0.485	0.258	-0.038	0.415	0.581	-0.079	0.183
LONG			1.00	-0.315	0.198	0.397	0.294	-0.258	-0.112	0.065	-0.283	-0.365
POP				1.000	0.032	0.192	0.086	0.973	0.569	0.286	0.990	0.684
LSRD					1.000	0.260	0.956	-0.042	0.457	0.041	-0.054	0.476
HSRD						1.000	0.531	0.176	0.643	0.556	0.153	0.329
TOTRD							1.000	0.016	0.596	0.204	-0.002	0.517
LAW								1.000	0.516	0.307	0.981	0.575
VEHMI									1.000	0.636	0.489	0.783
LAND										1.000	0.258	0.329
URBAN											1.000	0.578
RURAL												1.000
Mean value	525,326	2.04	3.46	22,250	752	136	888	27.5	87,515	1,634	12,587	9,663

follows:

$$CLAIM = 418,629 - 1,436\ LSRD + 122.8\ RURAL$$

The variables are defined in Table 6.

The coefficient of determination (r^2) is 0.14 indicating that 86% of the variation among claims in the 85 counties is not explained by this equation. Although different variables appear to be the most significant, the r^2 for equations defining claims per capita is comparable.

It was apparent that none of the 11 explanatory variables used in this analysis had the capability to account significantly for the variation in claims experience among counties. The occurrence of tort claims appears to be random or else is dependent upon factors that have not been identified and probably can not be quantified.

Use of Warning Signs

Background

On the basis of contacts with County Engineers and other county officials through questionnaires and interviews, the research staff believes that all counties in Iowa conform with the provisions of the MUTCD [27]. There is no indication that any county fails to use all of the signs that are required by the MUTCD or that sign usage in any county is not consistent with generally accepted principles of engineering practice.

However, there are pronounced differences among counties in the extent to which more warning signs are used than are required in order to conform strictly with provisions of the MUTCD. Greater use of warning signs involves a conservative interpretation of visibility distances,

safe stopping sight distances, the degree of hazard associated with a particular situation, and other facotrs that properly influence a decision to use a particular warning device at a particular location.

County Engineers who use a minimum number of warning signs are convinced of the appropriateness of this course of action. They feel that the increased use of warning signs will tend to degrade the alertness of drivers and increase the expectation on the part of drivers that there will be a sign warning of every potential hazard.

A warning of every potential hazard is not possible. Too many situations, some of short-term duration, can arise on low-volume roads of typical design to expect that each can be anticipated and that a suitable warning can be afforded. Engineers who use fewer signs recognize this limitation and place more dependence upon drivers to be responsible for their own actions.

On the other hand, some County Engineers will use a large number of warning signs. The Engineers assume a considerable responsibility for alerting drivers to as many potential hazards as practicable. It is important to emphasize, however, that counties represented by both types of engineers are in conformance with the provisions of the MUTCD [27].

The Analysis

A hypothesis was formulated that there was no difference in tort claims experience that could be related to the extent of use of warning signs. This hypothesis was tested by means of a regression analysis that related tort claim experience to a subjective rating, made by the Principal Investigator, that rated counties on a scale from 1.0 to 10.0. The rating was based upon an evaluation of the extent to which a county's signing practices appeared to go beyond the literal provisions of the

MUTCD [27]. By this scale, literal adherence to the minimum provisions of the MUTCD was rated 1.0. The maximum extent to which the manual was interpreted broadly, thus leading to an increased use of warning signs, was rated 10.0.

Subjective ratings were made for 11 counties for which a face-to-face interview had been conducted with the county engineer. These ratings are summarized as follows:

Rating	Number of Counties
1	1
2	1
3	1
4	1
5	1
6	2
7	1
8	2
10	1

Ratings were correlated with the tort claims experience for 1977 and 1978. Claims experience for only the most recent two-year period was selected on the basis that signing practices largely reflect the point of view of the County Engineer, and some County Engineers had been in their current positions for only a few years.

Results of Analysis

Several forms of regression were tested. The best resulting equation was as follows:

$$\text{CLAIM 2} = 188{,}649 + 908{,}139\ \text{LAT} - 262{,}248\ \text{RATE}$$

where

CLAIM 2 = tort claims in county during 1977 and 1978, dollars

LAT = latitude of county seat, degrees minus 40 deg

RATE = subjective rating of signing practices (range 1.0 to 10.0)

The coefficient of determination (r^2) of this expression is 0.77. This equation suggests that the difference in signing practice would account for a difference of $2,360,000 in tort claims during the two-year period between a county with signing practices that meet the minimum standards of the MUTCD and the highest rated county, other factors being equal. In fact, tort claim experience during 1977 and 1978 ranged from zero to $3,800,000 in the 11 counties included in the sample.

Claims experience in this subsample of 11 counties was much more strongly correlated with latitude than was the case with the larger sample of 85 counties and the six-year experience ($r = 0.62$ for the subsample, $r = 0.21$ for the full sample). Also, because of the small sample size and the highly subjective nature of the rating variable, caution is necessary in interpreting the results of this analysis.

However, the analysis did not support the hypothesis that the claims experience is unrelated to the extent of sign usage. An inverse relationship clearly appears to exist. On the other hand, there is no evidence to suggest that the safety afforded the motoring public correlates with either the amount of tort claims or the number of signs. Travel may be as safe on highways in counties with fewer signs and a high claims experience as it is on highways in counties with more signs and a low claims experience.

Routine Blading of Loose-Surfaced and Unsurfaced Roads

The Problem

One troublesome area in respect to tort claims is that occasioned by routine blading operations for maintenance of loose-surfaced and unsurfaced roads. This activity is necessary in order to smooth the road surface to permit safe and efficient travel.

The presence on the roadway of the grader constitutes a hazard to other vehicular traffic. The hazard is increased further by the windrow of material that may be left behind the grader.

Roads of this type typically are sufficiently narrow that blading can be completed in two passes of the machine. Loose material most often is moved from one shoulder to the center of the road in a first pass and then moved from the center to the opposite shoulder in a second pass. When this is done, the windrow of loose material left in the center of the road between the first and second passes may constitute a hazard if it is sufficiently large and is struck at relatively high speed. (Less frequently, material will be cast from the center toward both shoulders or the reverse, from both shoulders toward the center of the road.)

A grader with operator usually is assigned to a specific area in a county for maintenance of all unpaved roads in that area, including snow removal. The operator, through experience, will develop a pattern of use of the machine that will optimize the proportion of productive time and provide the best possible maintenance service to the assigned roads. There generally is an effort to minimize the number of time-

consuming reversals in direction and the amount of unproductive (deadhead) travel. Deadhead travel also tends to generate complaints from the persons who see a grader traveling with its blade raised and feel that the machine is not being efficiently utilized. Therefore, the pattern of use that has been adopted often entails lengthy runs prior to reversing direction and completing the operation. This method may cause a considerable length of windrow to be exposed to traffic during the course of a working day.

Possible Solutions

There is no obvious solution to this problem. The hazard of the grader itself is minimized by the mandatory use of a flashing warning light mounted on the machine. However, the equipment may still represent a significant hazard on roads with restricted sight distances.

Furthermore, it is not practicable to afford warning signs such as are used for some moving maintenance operations. To do so would require a separate signing crew with a light truck working with each grader. Signs could be used at both ends of the roadway segment on which work is underway, which may be 10 miles or more in length, and at all intersecting roads. The signs would have to be relocated constantly as work progressed. Since counties in Iowa typically have about 11 or 12 graders, the added manpower requirements would impose financial demands substantially in excess of the fiscal capability of any county road department.

Two alternative work patterns for blading operations were investigated in an effort to determine a pattern that would minimize the exposure of windrows to traffic without significantly sacrificing safety

in other respects or introducing a substantial loss of efficiency. The first alternative would double the size of maintenance districts and assign two graders rather than one to each district. These machines would then work in tandem with one following the other at a distance sufficient for other traffic to pass the graders with relative safety. The second method would retain the principle of graders working singly but would attempt to minimize the amount of exposed windrow. In general, a grader would reverse direction at each intersection so that the exposed windrow would generally not exceed one mile and would seldom exceed two miles.

Case Study

The two alternative methods described above were tested through simulation for their probable effect on efficiency and safety. Two adjacent maintenance districts in Jasper County were used as the study area. As part of this study, research personnel determined the current blading patterns in use in these two districts and made time-motion studies of actual operations to provide input data for simulation.

The two districts studied included 120.7 miles of unpaved road. At an average working speed of 5.75 mph, one complete round of two passes required about 42 hr of productive machine time for blading, exclusive of turns and deadhead travel. Reversals in direction were assumed to require 1.25 min of machine time each. Deadhead travel was assumed to take place at an average speed of 15 mph. The pattern of machine usage being employed was estimated to require 45.56 hours of grader working time, excluding time for machine maintenance and servicing, but including all turns and deadhead travel.

Using two graders in tandem would require slightly fewer reversals in direction but would quadruple the amount of deadhead travel, compared with the current pattern of usage. A 15% increase in machine working time would be required to blade the same number of miles of road. Safety advantages of the reduced exposure to windrow would be offset by the fact that one grader would always be working in a lane normally reserved for travel in the opposite direction.

The pattern using a single grader but directed toward the minimization of exposed windrow would more than double the number of reversals in direction required and would more than triple the amount of deadhead travel. A 16% increase in machine time would be required compared with the current method. Safety advantages of the reduced windrow exposure would be offset by the substantially increased time that the grader would be maneuvering to turn around, a time when it is especially susceptible to collision with other vehicles.

A comparison of the time requirements for the three blading patterns studied is afforded by Table 8.

Table 8. Comparison of working time for three blading methods.

Method of operation	Number of turns	Deadhead travel (miles)	Machine time required (hours)			
			Blading	Turns	Deadhead	Total
Current system	59	33.85	41.97	1.23	2.26	45.46
Graders in tandem	52	137.3	41.96	1.08	9.15	52.19
Minimum windrow	145	114.8	41.96	3.02	7.65	52.63

Curve Advisory Speeds

An issue in many of the tort claims submitted against counties is the allegation that an accident occurred because of failure to use an advisory speed plate in conjunction with a curve warning sign. This situation has arisen most frequently from accidents on loose-surfaced roads.

A procedure for establishing advisory speeds at curves on paved surfaces is well established (see Appendix C). However, previous research has not determined the suitability of this procedure on loose-surfaced roads. Consequently, a supplementary study conducted as part of this research dealt with the determination of advisory speeds on curves on loose-surfaced roads.

Study Design

For this study, trial runs were made on 10 curves located on loose-surfaced roads in Story County. The degree of curve varied from 4°26' to 23°35'.

Four different vehicles were used in order to investigate the effect of vehicle suspensions on ball bank indicator readings. These vehicles were as follows:

- Vehicle 1: 1978 Chevrolet Malibu
- Vehicle 2: 1967 Ford pickup
- Vehicle 3: 1968 Plymouth sedan
- Vehicle 4: 1977 Ford Ranchero.

Each trial run was made with a ball bank indicator mounted in the vehicle. The amount of deviation from the vertical on the ball bank indicator

accounted for the combined effect of centrifugal force and superelevation of the highway.

Curves were driven at speeds of 15, 20, 25, 30, and, where possible, 35 mph. A ball bank indicator reading was recorded for each trial run. On some runs in some vehicles, a curve could not safely be negotiated at 35 mph. Other runs were completed at this speed but the vehicle either slid or research personnel felt that sliding was incipient at this speed. Incipient sliding was also judged to have occurred with Vehicle 1 on two curves at 30 mph.

Study Results

A number of factors introduce variability in the results of test runs on curves using a ball bank indicator on loose-surfaced roads. These include the following:

- Surface roughness or loose gravel.
- Longitudinal gradient.
- Lack of uniformity in the road cross section.
- Variation in vehicle suspension systems.

As a result of these factors, there was considerable scatter in the data developed from this study. However, certain clear trends developed that are useful in establishing a methodology for using a ball bank indicator to determine curve advisory speeds on loose-surfaced roads.

All of the data derived from this study were normalized by establishing the relationship between a ball bank indicator reading in degrees and the theoretical coefficient of cornering friction. The friction coefficient was calculated using the following equation:

$$f = \frac{V^2}{15R} - e$$

where

f = coefficient of cornering friction

V = vehicle speed, mph

R = radius of curve, ft

e = superelevation expressed as a decimal.

When normalized in this manner, the following relationship suitably described the data:

$$f = 0.0125\ D$$

where

D = ball bank indicator reading, deg.

From this, the following relationship may be established for an average condition (a condition closely approximated by the data for Vehicle 4):

D, degrees	Calculated f
10	0.125
12	0.15
14	0.175

However, the variation among vehicle suspensions was such that a range of values described the responses of the four vehicles used. This range was as follows (lowest values for Vehicle 1 and highest values for Vehicle 3):

D, degrees	Calculated f
10	0.10 to 0.16
12	0.125 to 0.19
14	0.15 to 0.22

Thus, a considerable range is apparent. This reflects the contrast between the relatively soft suspension of the 1978 Chevrolet Malibu and the harsh suspension of the 1968 Plymouth.

Lack of uniformity in the road cross section was manifested on all of the 10 curves by a significantly different average rate of superelevation in the outside lane than in the inside lane. The average superelevation for 10 curves was 0.086 in the inside lane and -0.039 in the outside lane, an algebraic difference of 0.125.

The difference in superelevation between lanes is sufficient theoretically to introduce a variation of 10 deg in ball bank indicator readings in runs at the same speed made in the outside lane compared with those made in the inside lane. In fact, ball bank indicator readings averaged only 3.5 deg higher on travel in the outside lane. This indicates that drivers of the research vehicles experience difficulty remaining in their own lane of travel when negotiating a curve to the left. This suggests yet another factor tending to introduce variability in ball bank indicator readings on loose-surfaced roads.

The effects of surface roughness, loose surfacing material, and longitudinal gradient caused some further perturbation of the data derived for different curves. However, the data were sufficiently consistent for all curves at each speed used for the trial runs to suggest

an appropriate methodology for determining curve advisory speeds on loose-surfaced roads.

Summary of Findings

Statistical Analysis of Tort Claims Experience

No useful insight into the occurrence of tort claims in a specific county was afforded by the statistical analysis. None of the correlations of explanatory variables with the amount of claims was sufficiently high to indicate that any of these variables were useful for predicting claims experience. Equations developed using multiple regression techniques also lacked significant explanatory capability. These findings suggest either that the occurrence of tort claims is almost completely random or that factors explaining their occurrence remain to be identified.

Use of Warning Signs

This analysis identified one factor that may exert an influence on tort claims experience. The results suggest a significant inverse relationship between claims experience and the extent to which usage of signs in a county, particularly warning signs, apparently exceeds the requirements of the MUTCD [27].

However, the admonition expressed previously is important. The small sample size and the subjective nature of the rating included as a variable suggest the need for caution in interpreting this finding. It also must be noted that this research has not demonstrated a relationship between the degree of safety afforded the traveling public and either signing practices or the amount of claims. It is quite possible that safer highways may attract more claims than older, less safe highways.

Routine Blading of Loose-Surfaced and Unsurfaced Roads

A comparison of alternative methods of blading loose-surfaced and unsurfaced roads demonstrated that a significant loss in the efficiency of use of maintenance manpower and equipment would occur with the adoption of either of the two methods that were studied as alternatives to the current method. Both alternative methods would serve to reduce the amount of windrow exposed to traffic during routine blading operations. However, both methods introduce other hazards to the extent that no significant improvement in safety could be anticipated with the adoption of either alternative.

Curve Advisory Speeds

The results of this study indicate that the procedure outlined in Appendix C, utilizing trial speed runs to determine curve advisory speeds, is suitable for use on loose-surfaced roads. However, office calculations can not sufficiently account for the effects of surface roughness to be used for this determination.

The specific ball bank indicator readings included in Appendix C are appropriate only as guidelines, however. Variations in vehicle roll, longitudinal gradient, superelevation, and surface conditions were shown to introduce substantial differences in the ball bank indicator readings that corresponded with the same requirements for cornering friction. This finding strongly suggests that engineering judgment is essential for interpreting the results of trial speed runs to determine an appropriate curve advisory speed.

Results of this research demonstrated that vehicle roll was an especially important variable in interpreting ball bank indicator readings.

This may be demonstrated using the four vehicles utilized in this research as an example. Displayed below are values for ball bank indicator readings determined by this research that imposed exactly the same requirement for lateral friction:

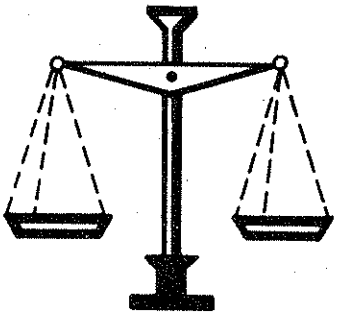
Average indicator reading, deg	Range of indicator readings, deg
10	7.5 to 12
12	9 to 14
14	11 to 16

The lowest values are associated with Vehicle 3 with a stiff suspension system and the highest values with Vehicle 1 with a soft suspension system. It may be seen that a range in indicator readings of up to 5 deg occurred with all factors equal except the vehicle in which the ball bank indicator was mounted.

This research also demonstrated that significant differences in ball bank indicator readings were attributable to the direction of travel. Because of the lack of uniform superelevation across the cross section of loose-surfaced roads on curves, permissible speeds will vary substantially between travel on the outside and inside lanes of a curve.

VI. CONCLUSIONS AND RECOMMENDATIONS

Conclusions



The threat of tort claims resulting from alleged highway defects introduces an additional concern to those charged with providing highway service. The possibility of such a claim means that any decision relating to highway design, construction, or maintenance may be reviewed subsequently in a court of law. In court, the good faith and competence of the decision maker will be challenged. A study of this problem suggests that the possibility of such a review may be inducing responses by county governments that are entirely defensive in nature and may exert an adverse effect on the safety and efficiency of highway travel. The installation of stop signs by several counties at low-volume highway-railway grade crossings is an example of a response that induces inefficiency in travel with no concomitant beneficial effect on safety.

An impression has often been expressed that the amount of highway-related tort claims against counties has been increasing over the past several years. Results of this research do not necessarily support this impression. In fact, very little increase in the amount of this type of claim occurred in Iowa from 1973 through 1977. However, the amount of highway-related claims submitted in 1978 was more than double the annual average for the preceding five year period. It is not

possible to state whether or not this experience indicates an increasing trend in claims over time.

The most frequently recurring theme in allegations against counties involves the use of traffic signs. An analysis of tort claim experience from 85 counties indicates that 56% of the total amount claimed arose because of alleged deficiencies in sign usage or traffic control. An additional 40% arose because of alleged roadway defects for which adequate warning could have afforded at least a partial defense against the claim. Thus, proper signing was a relevant issue in 96% of all tort claims against counties in Iowa in the period 1973 through 1978.

Analysis of experience from a sample of 11 counties indicates that there probably is a significant inverse relationship between the frequency of use of warning signs and the amount of tort damages claimed. The findings of this study indicate that claims probably will be reduced if usage of the warning signs exceeds the minimum expectations of the MUTCD [27]. However, there is no indication from this study that increased use of warning signs will exert any effect, favorable or unfavorable, on safety.

The use of stop signs on county roads in Iowa, based on impressions gained from this research, probably is much more extensive than would be consistent with the recommendations from studies reported in the technical literature. Such studies have reported that no significant reduction in the occurrence of accidents can be anticipated from the installation of stop signs at intersections previously having no control. This finding, from a study done for counties in Indiana, is summarized as follows:

> On the basis of accident records for the last three years, it was determined that there was no significant difference in the occurrence of accidents in the stop, yield, and no control intersections. [30]

The lack of effectiveness of stop signs as safety measures in many applications is reflected in generally accepted traffic engineering practice. This is exemplified by the following admonition from Section 2B-5 of the 1978 MUTCD:

> Stop signs should not be installed indiscriminately at all unprotected crossings. The allowance of stop signs at all such crossings would eventually breed contempt for both law enforcement, and obedience to the sign's command to stop.

About four accidents occur on secondary roads in Iowa per million vehicle-miles of travel. In view of the design characteristics of the county road systems, this accident experience indicates that an acceptable, perhaps even commendable, level of highway safety is being afforded on these roads. It can be concluded that counties in Iowa generally are affording safe and efficient travel on their highways.

Many of the imperfections in county highways simply can not be corrected, given the fiscal constraints within which county highways are constructed and maintained. For example, many of the larger claims against counties are based on geometric and structural deficiencies of highways and bridges. The only apparent solution is to reconstruct these obsolete facilities. However, a recommendation to do so would be trite and impracticable without assurance of substantially increased funding for county highways.

Any maintenance activity on a highway introduces an added element of hazard. The routine blading of loose-surfaced or unsurfaced roads

affords an example. Yet, findings from this research indicate that there are no practicable alternatives to the methods currently in use that are financially feasible and that would reduce the hazard inherent in this operation.

There is substantial evidence, both from the literature and from contacts with County Engineers, that the probability of success in a defense against a tort claim is substantially enhanced if there is detailed documentation of relevant facts. Such documentation should include a record of routine maintenance activities. It may be necessary to demonstrate after several years, for example, that a diligent effort was underway at a particular time to effect snow removal or blading of roads.

A sign inventory is particularly useful documentation when the matter at issue involves sign usage. It should be pointed out, however, that any written documentation can be a two-edged sword. Records may also be used to demonstrate that a good-faith effort was not being undertaken and thereby help establish that negligence of a county was the proximate cause of an accident.

It has been concluded from this research that the claimant (or plantiff) often has an advantage over a county when the details of an accident are obscure. Many examples were noted where the facts, when they became known, demonstrated that the proximate cause of an accident was the claimant's negligence, not a roadway defect as had been alleged. However, in the absence of facts it is usual to assume that there is at least a modicum of truth in the claimant's contentions. This assumption often has resulted in an adverse settlement or judgment for a county on

the basis of incorrect information. In many cases this problem could have been overcome if the County Engineer had been notified of an accident and been afforded the opportunity to establish and document the facts on the basis of an investigation made immediately after the accident occurred. This opportunity has not always been afforded.

Detailed Recommendations

Follow Strictly the Provisions of the Manual on Uniform Traffic Control Devices (MUTCD) in the Use of Warning Signs

The usual allegation in a pleading at law regarding warning signs is that failure to use a given sign is not in accordance with provisions of the MUTCD and violates the applicable statutes. Inherent is a presumption that a reasonable and prudent person would have used such a sign.

Despite this fact, the MUTCD [27] is surprisingly devoid of mandatory requirements in respect to warning signs. The auxiliary verbs "shall," "should," and "may" are not ordinarily used in connection with descriptions of their appropriate use. Instead, the manual in describing the situations calling for use of a warning sign commonly includes only the words "..sign is intended for use where...." There is no actual mandate in the MUTCD for the use of curve signs, turn signs, large arrow signs, cross road signs, stop ahead signs, or most other warning signs. However, the existence of such a mandate is often inferred in court when the failure to install a warning sign becomes the matter at issue.

Establish a Coherent and Carefully Documented Policy Governing the Use of Stop Signs

Indiscriminate use of stop signs, according to the 1978 MUTCD [27], will "eventually breed contempt for law enforcement, and obedience to the sign's command to stop." Excessive use of stop signs can be expected to exert an adverse effect on highway safety. Yet, a frequent allegation against counties is that there was negligence because of failure to install a stop sign at an unprotected highway intersection or railroad grade crossing.

The probability of such a case being successfully pursued will be reduced if each county develops a policy setting forth the circumstances under which stop signs are to be installed. The policy preferably would be adopted by resolutions. Exceptions to such a policy would be made only on the basis of a detailed traffic engineering study. All such engineering studies should be documented and retained permanently on file to support resolutions calling for installing a stop sign or to afford evidence of such a study in cases where a stop sign control was shown to be inappropriate. Use of stop signs at grade crossings of highways with railroads should be in accordance with current criteria developed by the Iowa Department of Transportation.

Establish a Continuing Sign Inventory Process

A sign inventory affords useful documentary evidence of the existence of a particular sign in a particular location at a particular time. It also provides a convenient mechanism for evaluating sign usage for conformance with standards.

Most counties have sign inventories. However, many are not current and some would be more embarrassing than helpful if introduced into evidence in a court proceeding. Each county should undertake a suitable sign inventory process. This should not be viewed as a one-time effort to catalog all existing signs with infrequent updates. Instead, sign inventory should be viewed as a continuing process in which the documentation is constantly updated as signs are added or replaced.

No specific inventory format is suggested. However, in counties in Iowa, both manual and computer-assisted processes are in use and can serve suitably as vehicles for documenting usage and evaluating signing practices. The assistance of a consultant will probably be necessary in the initial phase of implementation of a sign inventory process.

Establish Written Agreements Covering County Line Roads that Clearly Delimit Responsibilities

Findings from this research indicate that a disproportionate number of problems occur on county line roads. In many cases this results from a void in the assumption of responsibility for signing at county boundaries. Each county may assume that the other county will install certain signs with the result that neither county does so.

In other cases, discrepancies were noted in signing policies by adjoining counties, particularly in respect to stop control. As a result, the traveler on or crossing a county line road may find stop signs at one side of an intersection but none on the opposite side. The probability of a motorist being unaware of this discrepancy is sufficiently high to introduce a substantial safety hazard.

Written agreements covering county line roads should include an assumption of liability on the part of one county or the other. They also should detail specifically the responsibilities for all signing of these roads and their intersections as well as for routine maintenance functions. The Board of Supervisors of each county should officially recognize such agreements. No action regarding stop control at such intersections should be effected without the concurrence of each Board of Supervisors.

Similar arrangements are essential on roads on state lines or those forming the boundaries of cities.

Use of a Ball Bank Indicator to Establish Advisory Curve Speeds Where Needed

Advisory speed signs may be used with many types of warning signs. They are most frequently used, however, with curve signs and turn signs.

The appropriate advisory speed on a curve should be established by trial speed runs using a ball bank indicator to indicate the combined effect of centrifugal force and superelevation. This method is suitable for either paved highways or for loose-surfaced and unsurfaced roads. The procedures outlined in Appendix C suggest an appropriate methodology. It must be recognized however, that because of variations in vehicle suspension systems, the numerical values given in Appendix C are useful only for guidance. Judgment must be exercised to assure that travel at the advisory speed does not cause a feeling of discomfort to a driver within the curve or does not closely approach the speed of incipient sliding.

Two cautionary notes are necessary for trial runs on loose-surfaced or unsurfaced roads. First, the superelevation may vary substantially across the road cross section on a curve. It is important to adopt the same speed for both directions. This should be the lowest for the two directions as indicated by ball bank readings when travel is maintained within the appropriate lane. Second, surface roughness and variations in vehicle suspension tend to produce somewhat erratic results for ball bank indicator readings on this type of road.

Establish a Road and Sign Inspection Program

Many claims result from temporary conditions. A roadway may have been damaged by a flash flood, thawing may have caused surface irregularities or accumulations of water, or a sign may have been vandalized. Timely notice of such conditions is essential so that corrective action may be undertaken to alleviate a hazardous condition.

It is not possible for a single individual to patrol all of the highways in a county in less than several days. Therefore, it is necessary that all county road employees, and other county employees who regularly travel on county highways, be charged with the responsibility for reporting any hazardous conditions to the county road department office. Employees should be admonished particularly to note and report missing, damaged, or defective stop, yield, stop ahead, or intersectional signs or any defect in the road that they feel might cause an accident.

The assistance of the general public should also be solicited. This may be done through newspaper advertisements that request reporting

of missing signs or other defects and list a telephone number that will be answered at all times.

Establish a Program to Document Conditions Surrounding Accidents on Roads Under County Jurisdiction

County Engineers tend to feel that most large tort claims are unwarranted. They believe that driver negligence is the proximate cause of most accidents that give rise to such tort claims.

Generally, there is merit to this belief. However, the ability to defend such a case depends upon knowledge of many facts that are difficult to establish years after an accident when a claim may reach the settlement stage. Evidence concerning a highway condition may be well-documented. However, facts concerning driver and vehicle behavior will be lost forever unless they are discovered and documented immediately following an accident.

Important evidence may include skid marks, stains, and any marks made by a vehicle off the traveled way. These should be documented by the County Engineer (because no one else is likely to be sufficiently interested) as soon as possible after occurrence of an accident.

Photographs should be taken in profusion to include evidence from an accident as well as the conditions of the highway and any traffic control devices. Measurements of vehicle trajectories should be made so that the accident may subsequently be reconstructed. This evidence should be retained on file for at least five years and discarded only if no claim has resulted from an accident.

Develop Procedures to Assure Timely Notification of Accidents on Roads Under County Jurisdiction

The ability to respond appropriately to allegations of negligence due to roadway defects depends, in part, upon the ability to reconstruct the circumstances surrounding an accident that gave rise to a claim. This requires documentation that can be obtained only at an accident scene shortly following an accident. In turn, this requires that the County Engineer receive prompt notification of any highway accident on the county system that results in serious personal injuries. (Prompt in this case implies not more than a few hours from the time of occurrence of an accident to the time of notification.)

The mechanism for such prompt notification apparently exists currently in only a few counties and only if investigation is by the County Sheriff's Department. Each county should effect arrangements to assure timely interchange of accident information between the offices of the Sheriff and the County Engineer. A suitable arrangement is also necessary to ensure that the Iowa State Patrol will advise the county of accidents that they investigate on county highways. This can best be done utilizing radio communications between the responsible Patrol Post Headquarters and the County Sheriff with telephone relay to the County Engineer.

Additional Research Needs

It has been stated previously in this report that there is no evidence that an increase in the extent of usage of warning signs will exert a favorable effect on highway safety. The converse is also true.

There is no evidence that it will not exert a favorable effect on safety. It is quite likely that both effects can be demonstrated, that there is an optimum level of warning sign usage that will be associated with the lowest level of accident occurrence. Either too few or too many warning signs may affect safety adversely. Research could be undertaken that would demonstrate this effect. The level of usage of warning signs within a county, taken from sign inventories, could be compared with the accident frequency, taken from state accident records and normalized to account for differences in exposure.

No entirely suitable method of determining curve advisory speeds is currently available, especially for loose-surfaced roads. The methodology outlined in Appendix C presumes that a constant relationship exists between a ball bank indicator reading and the requirement for cornering friction imposed by a vehicle negotiating a particular curve. Research reported here indicated that this is not correct, that this relationship will vary substantially depending upon characteristics of the suspension system of the test vehicle and other factors. Hence, the interpretation of ball bank indicator readings to determine a suitable advisory speed is highly dependent upon the judgment of the person making the trial runs. More extensive research is required to define better the relevant parameters and to suggest a method for properly interpreting ball bank indicator readings for this purpose.

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APPENDICES

APPENDIX A

THOUGHTS ON INVESTIGATION OF ROAD CASES

THOUGHTS ON INVESTIGATION OF ROAD CASES*

Though it is difficult to prepare an investigation outline for every type of road case, the information set out following should be helpful to an investigator handling a road or sign defect case. A substantial portion of the following information will prove quite helpful in such type case. Investigation to be considered should be as follows:

1. Visit the scene of the accident and take note of all pertinent details before conducting a thorough investigation. In this regard, it might be helpful to have the public official in charge of the road visit the scene with the investigator.

(a) Determine the nature of signing or controls present at the location of the accident;

(b) Do the signs or controls which were present on the date of accident conform to the Manual on Uniform Traffic Control Devices for Streets and Highways;

(c) Obtain measurements on the distance placement of signs or controls and the height of signs or controls;

(d) Determine road markings, etc., at the scene;

(e) Do the markings conform to the Uniform Manual;

(f) Determine the nature of the pavement and measurements of the width, shoulder, and lane width at or near the scene;

(g) Determine the nature of the road surface;

(h) Determine what obstructions, defects, etc., which could cause or contribute to the accident existed at the scene on the date of accident;

(i) Determine speed zones and warning signs, etc., close to or approaching the scene of the accident;

(j) Determine if other parties having some relationship to the area in question could have caused or contributed to the accident (adjacent landowner, etc.);

2. Prepare a detailed diagram of the scene of the accident.

(a) Show the accident and the paths of the vehicles leading up to and after the accident;

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*The source for this Appendix A is [25].

(b) Show pertinent measurements, distances, skid marks, debris locations and defects on the diagram;

(c) Show appropriate signing and measurements at or near or leading up to the scene;

(d) Show the nature of the area surrounding the scene--rural, residential, etc.--and what structures, buildings, obstructions are located nearby.

3. Obtain complete copy of the police report including all statements, supplemental reports, photographs, etc.

4. Determine whether to secure signed, recorded or court reporter type statements from investigating police officers and witnesses on police report.

(a) Pay particular attention to details helpful to reconstructing accident such as measurements on skid marks, debris, vehicles and locations, etc.;

(b) Look for admissions or statements of persons at the scene and determine whether to develop these more or simply to preserve them.

5. Obtain the Coroner's Inquest, autopsy and/or pathology report and determine whether to contact witnesses to commit them to specific details or to expand their testimony regarding the accident.

6. Obtain copies of all newspaper stories on the case.

(a) Determine the writer of the article and interview the writer for further pertinent details;

(b) Determine photos available and obtain copies of pertinent photos.

7. Obtain photos of the scene of the accident - preferably printed 8" x 10", black and white.

(a) Keep in mind the photos may be useful in interviewing witnesses, taking depositions, as well as for use at the time of trial;

(b) Take shots approaching the accident scene from two or four directions (where pertinent) at various distances (e.g. 2000', 1000', 500', 300', 100', 50');

(c) Take close-ups at the scene - gouge marks, road markings, etc.:

(d) Use a rule, tape or other measuring instrument in some, but not all, photos where pertinent.

8. Obtain ambulance reports and consider interviewing the attendants.

(a) If the attendants are not interviewed, at least determine their names, addresses and phone numbers for future reference.

9. Determine the location of the vehicles involved in the accident and obtain photographs.

(a) Consider a number of different shots of the vehicles if the photos will someday be needed by a reconstruction expert;

(b) Determine the names, addresses and phone numbers of individuals and/or companies who towed the automobiles from the scene and determine whether to interview such individuals.

10. Perform a canvass of the area or neighborhood for witnesses to the accident itself for pre or post-accident details if this is helpful.

(a) Determine whether statements should be secured. If so, determine whether they should be written, recorded or court reported.

11. Obtain a map or maps of the area (e.g. County or Township) showing who owned or had jurisdiction of the road or roads in question.

12. Determine if specifications on cars involved in the accident may later be necessary (e.g. the width of the automobile on a very narrow road) and, if so, obtain specifications from the manufacturer.

13. If the volume of traffic is pertinent, obtain a copy of a map with the latest traffic count for the road or roads in question.

14. Determine if there is a file on the road and obtain copies of the materials of the file such as work repair records, contracts for repairs or construction, complaints, telephone calls and/or letters regarding the road in question.

15. Determine if there is any joint sharing of maintenance responsibility or trade-offs of such responsibility with other governmental bodies. If so, obtain a copy of such agreement if written, or complete details if oral.

16. Determine the budget for the year in question of the governmental body responsible for the road and the allocation for the road in question and whether all funds were expended.

17. Obtain a detailed statement from the official in charge of the road. That statement should include the following details:

(a) The full name, home and business address, home and business phones of the official in charge of the road - County Superintendent of Highways, Township Highway Commissioner, Superintendent of Streets, etc.;

(b) The date that he first took the job, his exact job title, his educational background and work experience, especially on roads.

(c) The number of miles of roads under his jurisdiction and whether the roadway in question was under his jurisdiction;

(d) The history of the road in question, the date constructed, the date dedicated, the date accepted, and the dates and nature of substantial reconstruction or repairs including any signing which might be pertinent to the case:

(e) Is the road possibly partially in another jurisdiction? If so, which? Is there any maintenance sharing agreement? If so, copies of the complete details of such agreement should be obtained:

(f) Is it possible that roads leading up to the scene are in different jurisdictions? If so, determine what jurisdictions;

(g) Determine the number of employees for the highway department in question and obtain the full names, addresses, phone numbers and job titles and job duties of such employees;

(h) Which employees worked on the road in question that is pertinent to the accident. Determine the dates, the nature of work and any work records involved;

(i) Generally, what maintenance records on roads and signs are kept by the highway department in question? By whom, for how long? What do these records show with respect to the roadway in question?

(j) Where pertinent, who else (individual or governmental body) worked on the road that might have caused or contributed to the accident?

(k) Is the road in question a motor fuel tax road? Does he have a copy of the map submitted to the state so indicating? If not, who does?

(l) What maps or diagrams does he have showing the road in question falling within his jurisdiction;

(m) Regarding the road in question, determine the details such as the nature of pavement, the width of the paved portion, the width of the shoulder, markings on the road, speed limit and whether posted, signs at and leading up to the scene, whether the signs conform to the Uniform Manual in size, shape, color, reflectorization, height and placement. Were any changes in these contemplated before the accident? Were any changes actually done after the accident? Are any changes presently contemplated? If so, obtain complete details;

(n) If pertinent to the case, have there ever been speed studies on the road in question to change the speed zone? If so, the number of studies, the dates of such studies and the results. Has or will the speed limit on the road be changed?

(o) Is there a history of prior accidents, repairs, maintenance problems, or complaints regarding the location in question? What records are maintained on this? Obtain full details;

(p) What is the lighting at the location in question both presently and on the date of the accident?

(q) Has he ever consulted with any other traffic officials regarding the road or the area in question? The nature of such consultation and advice requested, the dates, from whom, and what was actually received, should be obtained;

(r) What budget does he have for the department for the year of the date of accident? What was allocated to this road and what was actually spent on this road?

(s) What effect, if any, does or did the weather have on the date of accident on the road in question?

(t) Did the highway department in question have any type of road inspection program which would serve to locate defects with respect to the roads or signs in question? If so, who is in charge of such road inspection program? A full and detailed explanation of the program should be obtained. The number of inspections carried out, the nature of such inspections, and the frequency of such inspections should be determined. It also should be determined whether the accident in question could possibly have been avoided had the inspection system been complied with at the time of the accident. Was the inspection system complied with at the time of the accident? Would any type of reasonable inspection system have revealed the defect in question?

(u) Is it possible, in the opinion of the official in charge, that the accident would have been avoided if there was a different design on the road in question? If so, what would the cost of the different design have been and what would have been the nature of the different design?

(v) What does the highway official in question consider to be his duties and responsibilities? What does he refer to as the source of his job duties or responsibilities? Does he rely upon certain books or manuals in his work? If so, the full details regarding the nature of such books or manuals should be obtained;

(w) If the case involves signs, were all of the signs installed at the location of the accident in compliance with the Illinois Manual on Uniform Traffic Control Devices for Streets and Highways? If they were not, how were they not in compliance? Also, is it possible that there should have been other or additional signing at or near the scene of the accident in question? If so, what is the nature of that other or additional signing?

(x) What is the nature of the top surface of the roadway in question? Is it possible that the roadway in question was made of Portland Cement concrete, bituminous concrete or brick so that it could become part of the state highway system pursuant to Ch. 121, § 5-404 and § 5-403 of the Illinois Revised Statutes?

(y) Is the highway official in question personally familiar with the roadway and the location of the accident in question?

(z) Is the highway official in question aware of any resolutions or ordinances dealing with the roadway or signs on the roadway in question? If so, what are these ordinances, where can they be copied or obtained, and who is responsible for the passage of such ordinances or resolutions.

(aa) Did the highway department in question have any type of telephone log which might record or have a record of incoming calls regarding the roadway or signs in question? If so, copies of these records should be obtained and detailed information should be obtained as to how the telephone log system operated:

(bb) Is the highway official in question of the opinion that the roadway in question meets all the standards or specifications which it should meet in Illinois? Does he feel that the road is in need of improvement, either from a design standpoint or from a signing standpoint? If so, what does he feel the improvements should be and does he feel that these are required by any state statute or administrative policy? If so, what?

18. The highway official should review the factual allegations of the Complaint in the case. Then it should be determined what information the official has with respect to the facts of the accident involved. For example, he might be able to comment with respect to the reputation of the witnesses for truthfulness and so forth. He might have an opinion with respect to each one of the factual allegations alleged in the Complaint. If he does, this should be gone into;

19. Finally, the highway official in question should be asked to accompany the investigator to the scene of the accident and go over the details of the allegations of the Complaint and the investigation revealed to date and his comments obtained while reviewing the scene of the accident in question.

The investigator should keep in mind that he may take a very detailed statement from the public official in charge of the road. This will not be discoverable. The public official will generally be a Defendant in the lawsuit or a potential Defendant in the lawsuit and, therefore, his statement will not have to be produced during the course of discovery. At the same time, the investigator should be mindful that statements taken from employees will be producible during discovery. Thus, any statements from employees should be very carefully worded and very careful thought and consideration should be given to whether or not to secure such a statement in the first place. Statements may be secured on very specific information which might be helpful to the case omitting to cover other areas which might not be quite as favorable. A good deal of judgment and discretion must be exercised by the investigator handling these type of cases.

Also, during the course of the investigation, the investigator will be called upon to use his best judgment as to the nature of statements to be taken. Of course, it goes without saying that there is much more control by the investigator in taking a signed statement. A recorded statement likewise can be somewhat controlled but certainly there is not as much control as in the signed statement. A court reporter statement furnishes almost no control whatsoever. Ordinarily, the investigator will wish to take favorable statements either in the form of a handwritten statement or a carefully worded recorded statement. Unfavorable statements quite often would best be taken through a court reporter. Again, good judgment and discretion on the part of the investigator is advised.

APPENDIX B

QUESTIONNAIRE FORM

Iowa State University of Science and Technology Ames, Iowa 50010

Engineering Research Institute
College of Engineering
104 Marston Hall
Telephone: 515-294-2336

November 21, 1978

The Engineering Research Institute at Iowa State University has contracted with the Iowa Department of Transportation to conduct research directed toward enhanced safety in the construction and maintenance of county roads. Specific objectives of this research are as follows:

1. To define the magnitude (dollar amount) of the problem relating to tort claims resulting from alleged negligence in the construction and maintenance of county roads.

2. To determine in considerable detail the specific deficiencies that allegedly resulted in an accident or other incident affording a basis for a tort claim against a county.

3. To develop a checklist or set of guidelines that will address the specific deficiencies that have been alleged and will assist County Engineers in improving safety on county roads and in reducing the potential liability from such incidents.

We are aware that information relating to tort claims has recently been solicited from the counties by the National Association of County Engineers and the Iowa State Association of Counties. Both of these organizations are cooperating with our effort. Milton Johnson, P.E., President of NACE, and the ISAC have both made the responses to their questionnaires available to us. However, the information obtained from the earlier questionnaires is not sufficiently detailed to be responsive to our needs. We therefore solicit your cooperation in completing the enclosed questionnaire and returning it to us.

Our interest is only in those tort claims that result directly from the county's responsibility for constructing and maintaining (including traffic control) a highway system. Claims resulting from accidents involving county vehicles need not be included unless the vehicle was involved directly in a construction or maintenance activity at the time of the accident. Please include any such claims for which action was initiated during the period January 1, 1973, to the current date, or any earlier claims for which disposition is still pending.

You will note that we have requested that the questionnaire be signed by both the County Engineer and the County Attorney. We have found that, since the settlement of tort claims normally has been handled for you by your insurer, county officials often are not closely involved in the settlement and cannot always recall all of the relevant claims. It is our expectation that the recollections and records of two officials will be more complete than those of only one official.

We have attempted to structure the questionnaire so as to reduce your burden in completing it and to minimize the duplication with the other surveys. Please note, however, that we need as much detail as you can afford in describing the situation that led to a claim. In fact, a copy of the Petition at Law that summarized the cause of action will serve admirably to describe the specific allegations and will save you the trouble of writing them out.

If you have any questions concerning our objectives or what we are seeking on the questionnaire, please call me at (515) 294-6777. Thank you for your time and effort in completing the enclosed questionnaire. The results of our research will be available by next October and, hopefully, will be helpful to you.

Sincerely yours,

R. L. Carstens, P.E.
Professor of Civil Engineering

RLC/dlb
enclosure

HIGHWAY RELATED TORT CLAIM EXPERIENCE QUESTIONNAIRE

Name of individual completing survey _____ County _____ Title _____

Address _____ City _____ Telephone _____

On the attached pages, please list your highway-related tort claims initiated during the years 1973 through 1978, and any other claims for which disposition is pending.

Include the following information:

a. Year claim initiated.

b. Dollar amount of claim.

c. How claim was disposed of.

d. Year in which settlement or judgement was determined.

e. Dollar amount of settlement or judgement.

f. Specific Allegation that afforded the basis for those claims. (Please include as much detail as possible or attach a copy of the relevant Petition at Law.)

If your county has had no highway-related tort claims during the period covered, please check here and return this page, completed and signed as indicated.

No relevant claims ☐

Survey information has been reviewed by:

Signature of County Engineer _____ Signature of County Attorney _____

Return completed form to:

R. L. Carstens
Engineering Research Institute
382 Town Engineering Building
Iowa State University
Ames, Iowa 50011

TORT CLAIM INFORMATION

Claim number

1. a. 19___
   b. $_____
   c. Settlement____ Judgement____ Dismissed____ Still Pending____
   d. 19___
   e. $_____
   f. Details of specific allegations:

2. a. 19___
   b. $_____
   c. Settlement____ Judgement____ Dismissed____ Still Pending____
   d. 19___
   e. $_____
   f. Details of specific allegations:

3. a. 19___
   b. $_____
   c. Settlement____ Judgement____ Dismissed____ Still Pending____
   d. 19___
   e. $_____
   f. Details of specific allegations:

APPENDIX C

DETERMINATION OF ADVISORY CURVE SPEEDS

DETERMINATION OF ADVISORY CURVE SPEEDS

The following procedure is adapted from [31,32] and is suggested for determination of advisory speeds on curves on paved surfaces. Two different methods are available for making such a determination: 1) by office calculation and 2) trial speed runs with a test vehicle. It is suggested that an office calculation be carried out and that this be verified by field runs as a check.

Office Calculation

The following equation may be used to determine an advisory speed on a horizontal curve:

$$V = \sqrt{15(e + f)R}$$

where

V = advisory speed, mph

e = superelevation expressed as a decimal

f = coefficient of cornering friction (see values tabulated below)

R = radius of curve, ft

This is a trial-and-error procedure since f varies with V as follows:

V, mph	f
30	0.16
40	0.15
50	0.14

A coefficient must first be assumed and then V is calculated. If the calculated speed is not consistent with the originally assumed f, as

indicated above, a further calculation should be made using another assumed f. The process is repeated until consistency is achieved. Results of the office calculation should be verified by trial speed runs.

Trial Speed Runs

The appropriate advisory speed for a horizontal curve may be determined by a test car. A ball bank indicator should be mounted in the test car.

Before a test run is started, the ball bank indicator is leveled to read "zero" when the vehicle is positioned on a level surface. The speed of the initial test run is selected as some multiple value of 5 mph and should provide a reading of less than 10 degrees on the ball bank indicator near the middle of the curve. Succeeding test runs are then made at increasing 5 mph increments until the reading on the ball bank indicator exceeds the desired value.

Safe speeds on curves are suggested by ball bank readings of 14° for speeds below 20 mph, of 12° for speeds between 20 and 35 mph, and of 10° for speeds of 35 mph and higher. This reading shows the combined effect of centrifugal force, superelevation, and vehicle body roll. (Although the guidelines given above are suggestive of the appropriate advisory speed, they do not necessarily account for the difference in body roll among vehicle types.) The value selected should represent the transition point at which the centrifugal force begins to cause a feeling of discomfort to the driver within the curve.

Several runs are often made in each direction to verify the selected advisory speed. The speed determined from this study should then be rounded to the nearest 5 mph for the advisory speed sign to be posted in the field.