Project #: E-20-831
Center #: T5173-0A0

Contract#: TASK ORDER 13 UNDER BOA 11/9/8 Mod #:
Prime #: 
Subprojects ?: N
Main project #: 

Project unit: CE Unit code: 02.010.116
Project director(s): MOSKALUK M J CE

Sponsor/division names: GA DEPT OF TRANSPORTATION / 
Sponsor/division codes: 300 / 035

Award period: 880101 to 881231 (performance) 881231 (reports)

Sponsor amount
Contract value 125,000.00
Funded 125,000.00

Cost sharing amount

Does subcontracting plan apply ?: N

Title: TECHNOLOGY TRANSFER PROGRAM (6TH YEAR)

PROJECT ADMINISTRATION DATA

OCA contact: Brian J. Lindberg 894-4820

Sponsor technical contact
PETER MALPHURS (404)363-7510
GA DOT - OFF OF MATERIALS & RESEARCH 15 KENNEDY DRIVE
FOREST PARK, GEORGIA 30050-2599

Security class (U,C,S,TS) : U
Defense priority rating : N/A
Equipment title vests with: Sponsor X GIT

ONR resident rep. is ACO (Y/N): N
N/A supplemental sheet

Administrative comments - FOLLOW-ON TO PROJECT E-20-606.
TASK ORDER UNDER BOA #90
NOTICE OF PROJECT CLOSEOUT

Date 3/6/89

Project No. E-20-831  Center No. T5173-OA0

Project Director M. J. Moskaluk  School/Lab CE

Sponsor Georgia Department of Transportation

Contract/Grant No. Task Order 13 under BOA 11/9/87 *  GTRC XX GIT

Prime Contract No.  

Title Technology Transfer Program (6th Year)

Effective Completion Date 1/20/89 (Performance) 1/20/89 (Reports)

Closeout Actions Required:

- None
- X Final Invoice or Copy of Last Invoice
- Final Report of Inventions and/or Subcontracts
- Government Property Inventory & Related Certificate
- Classified Material Certificate
- Release and Assignment
- Other

Includes Subproject No(s). 

Subproject Under Main Project No. 

Continues Project No. E-20-606  Continued by Project No. 

Distribution:

X Project Director  X GTRC  
X Administrative Network  X Project File  
X Accounting  X Contract Support Division (OCA) (2)
X Procurement/GTRI Supply Services  
X Research Property Management  
X Research Security Services  

Y Reports Coordinator (OCA)
RESEARCH PROJECT PROGRESS REPORT
DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA

Project No. 808 (GDOT) E20-831 (GT)
Project Title Technology Transfer Program for Local Transportation Agencies

Report No. 21
Report Period from January 1, 1988* to June 30, 1988

Research Agency(s)
GEORGIA INSTITUTE OF TECHNOLOGY
ATLANTA, GA 30332

Project Director(s)
M. JOHN MOSKALUK

Starting Date 1/1/88
Completion Date 12/31/88

% Time Expended 50%
Schedule Status
☒ On
☐ Ahead
☐ Behind

Funds Authorized Total $125,000
Funds Expended Total, % $48,823, 39%
Fiscal Year Funding Authorized %
Expended, %

Project Objectives, Status, Progress

Report Date 7/21/88

*Project's actual start date (expenditure of funds) was March, 1988, because of continuation of previous Technology Transfer Project.

PROJECT GOAL:
To communicate to local transportation agencies the availability and application of new technology that bridges the gap between research and implementation in the area of roadways, bridges, and transit.

OBJECTIVES:

- To enhance the existing programs of technology services of GDOT and Georgia Tech.
- To improve and further promote communication on technical transportation issues between GDOT, Georgia Tech, and the local agencies.
- To help insure that appropriate technology consistent with the needs of the local agencies is made available.
- To encourage implementation of effective procedures, practices, and materials at local levels.
STATUS:

The three major tasks of the project are: conduct training seminars, publish a quarterly newsletter, and respond to requests for information and assistance.

The workshop on Right-of-Way Acquisition, "Basic Relocation", was presented in all seven DOT districts, with dates and attendance as follows:

<table>
<thead>
<tr>
<th>Location</th>
<th>Date</th>
<th>Attendance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chamblee</td>
<td>5/31</td>
<td>37</td>
</tr>
<tr>
<td>Thomaston</td>
<td>5/17</td>
<td>17</td>
</tr>
<tr>
<td>Gainesville</td>
<td>5/24</td>
<td>9</td>
</tr>
<tr>
<td>Cartersville</td>
<td>5/26</td>
<td>13</td>
</tr>
<tr>
<td>Jesup</td>
<td>5/10</td>
<td>18</td>
</tr>
<tr>
<td>Tifton</td>
<td>5/12</td>
<td>14</td>
</tr>
<tr>
<td>Tennille</td>
<td>5/18</td>
<td>10</td>
</tr>
</tbody>
</table>

The spring edition of TechTrans was published, and 1900 copies were distributed. In addition to responding to requests for publications and technical assistance, the Center has loaned 12 video tapes from its library during the quarter.

Seven presentations of the two remaining right-of-way workshops will be held in September, 1988. ("Business Moves" and "Decent, Safe, and Sanitary Housing" will be presented in a combined format on one day.) Dates have been set for the workshop and district auditoriums reserved.

M. John Moskaluk, Director
Technology Transfer Center
Georgia Tech
## PROJECT GOAL:

To communicate to local transportation agencies the availability and application of new technology that bridges the gap between research and implementation in the area of roadways, bridges, and transit.

### OBJECTIVES:

- To enhance the existing programs of technology services of GDOT and Georgia Tech.
- To improve and further promote communication on technical transportation issues between GDOT, Georgia Tech, and the local agencies.
- To help insure that appropriate technology consistent with the needs of the local agencies is made available.
- To encourage implementation of effective procedures, practices, and materials at local levels.

### STATUS:

The three major tasks of the project are: conduct training seminars, publish a quarterly newsletter, and respond to requests for information and assistance.
The summer edition of TechTrans was published, and 2500 copies were distributed.

The Center has prepared two half-day workshops which are designed to be presented "on-site", i.e. the local shop facility. Both topics are offered as a video presentation with accompanying manuals and handouts. "Operator Daily Maintenance Procedures for Roadway Construction Vehicles" provides basic instructions and checklists for the maintenance of light trucks, motor graders, dump trucks, crawler tractors, front end loaders, asphalt distributors, and rollers. "Roadway Maintenance Procedures" provides step-by-step instructions and suggestions for the repair of the subgrade and base, potholes, depressions, rutting, corrugation, and cracks, as well as for the application of single and multiple surface treatment. Several presentations of both topics are scheduled to be presented during the month of October. Workshops on unpaved roads and cleaning bridges and ditches are being prepared.

Seven presentations of each of the right-of-way workshops covering the topics of "Business Moves" and "Decent, Safe, and Sanitary Housing" will be held in October, 1988. Brochures for the workshop have been sent to the district engineers and right-of-way personnel.

The Georgia Department of Transportation is currently considering whether or not to renew the contract of the Technology Transfer Center. In keeping with this effort, the Technology Transfer Center, with the Georgia Department of Transportation, is working to evaluate the effectiveness of the Center. Subjective and objective evaluations have been prepared.

The Center continues to distribute technical information and publications as well as provide technical assistance where needed.

\[\text{M/John Moskaluk, Director} \]
\[\text{Technology Transfer Center} \]
\[\text{Georgia Tech} \]
GEORGIA TECH
TECHNOLOGY TRANSFER CENTER

ANNUAL EVALUATION REPORT

Prepared By:
Georgia Tech
Technology Transfer Center

Submitted To:
Federal Highway Administration
and
Georgia Department of Transportation

GEORGIA INSTITUTE OF TECHNOLOGY
A UNIT OF THE UNIVERSITY SYSTEM OF GEORGIA
SCHOOL OF CIVIL ENGINEERING
ATLANTA, GEORGIA 30332
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<th>Section</th>
<th>Page</th>
</tr>
</thead>
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<td>CENTER ACTIVITIES</td>
<td>3</td>
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<td>Mailing List</td>
<td>3</td>
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<tr>
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<td>Newsletters (Tech Trans)</td>
<td>7</td>
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<tr>
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<td>EVALUATION</td>
<td>10</td>
</tr>
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<td>CONCLUSION</td>
<td>12</td>
</tr>
</tbody>
</table>

### APPENDIX

- APPENDIX A--Mailing List
- APPENDIX B--Publication List
- APPENDIX C--Video Tape List
- APPENDIX D--Newsletters
- APPENDIX E--Evaluation Reports
  - Georgia Tech Technology Transfer Center Evaluation Questionnaire Summary - Prepared by Georgia Department of Transportation, Office of Materials and Research, Mr. Peter Malphurs, August, 1988.
ABSTRACT

This report is the final report for the sixth year contract of the Georgia Tech Technology Transfer Center. It will document the activities of the Technology Transfer Center during its sixth year of operation. Since the contract of the Center has not been renewed for a seventh year, the report will also serve, to some extent, as an evaluation of the Center during its entire tenure. Tallies and summaries will be provided concerning the workshops, newsletters, mailing list, and video tape library, as well as the distribution of technical publications and assistance.

In brief, the Center maintains a mailing list which, at present, contains almost 2400 entries, a publication list of 354 entries, and a video tape library containing thirty-eight tapes. Documentation on each of these lists is contained in the appendices. Also, the Center has sponsored ten workshop sessions at Department of Transportation District Offices, at which $3,900 in registration fees were received. One session was conducted at the Corps of Engineers in Savannah, and twelve sessions were conducted in local agencies. The total attendance for the workshops was 483 persons. Regarding the newsletter, the Center distributed approximately 2500 copies each quarter (Copies of each newsletter are found in the Appendix D).

Evaluation of the Center's sixth year activities will include the results of a survey conducted by Mr. Hal Rives, Commissioner of Transportation. The survey solicited the responses of local cities and counties regarding their awareness of the Center's services and the value of such services. In addition an independent evaluation was conducted by Mr. Grover Bowman under subcontract with the Center.
INTRODUCTION

The Georgia Tech Technology Transfer Center was established to bridge the gap between research and implementation in the area of roadways, bridges, and transit. The Center achieves this goal by encouraging awareness and implementation of effective procedures, practices, and materials at local levels. In doing so, the Center seeks to enhance communication with and programs provided by the Georgia Department of Transportation.

The GDOT has divided the 159 counties in the State into seven districts. Some of the district staff that the Center deals with includes the District Engineer, Maintenance Engineer, Construction Engineer, Traffic Engineer, and Training Officer. During the years, a strong working relationship has developed between the local agency staff and the GDOT. Most of the technical assistance received by the local agencies comes through GDOT, and it is this route of assistance that the Technology Transfer Center seeks to tap into and expand upon.

When the Center started its operation, it quickly realized the advantage of using the GDOT relationship with the local jurisdictions as a vehicle to get the program underway and to begin to establish credibility. The efforts of the Center are coordinated with those of the GDOT through the District Engineers, GDOT liaison (Mr. Percy Middlebrook) and with other GDOT Engineers. Further, work with the Federal Highway Administration is coordinated through the FHWA liaison (Mr. Andy Hughes) and other FHWA staff.

Center activities are monitored by two committees. These committees are the Technical Advisory Committee and the Policy Advisory Committee. The Technical
Advisory Committee is composed of Mr. Andy Hughes (FHWA), Mr. Percy Middlebrook (GDOT), and Dr. John Moskaluk (Georgia Tech). The prime function of this committee is to oversee the daily activities of the Center and to provide guidance to the Center Director.

The Policy Advisory Committee is composed of Commissioner Hal Rives (GDOT), Mr. Peter Malphurs (GDOT), Mr. Louis Papet (FHWA), Mr. Erwin Kee (FHWA Advisory), Mr. Jerry Griffin (Association County Commissioners), Mr. James Burgess (Georgia Municipal Association), Dr. Edmund Fitzgerald (Georgia Tech), and the Technical Advisory Committee. The function of this committee is to provide policy guidance to both the Technical Advisory Committee and to the Center Director. The committee deals with the broad issues concerning center strategy as well as specific issues such as workshop topics.

At the present time, the Center staff consists of John Moskaluk, Center Director, and his assistant, Marty Milliner, as well as three part-time graduate students: Jeff Bump, Todd DeVos, and Shahram Malek.
CENTER ACTIVITIES

Mailing List

The mailing list contains almost 2400 entries and can be sorted by agency type, GDOT district, or employee type.

Included on the mailing list are Street Superintendents, City and County Engineers, City and County Maintenance Personnel, Law Enforcement Officials, County Commissioners, Area Planning and Development Commissions (APDC's), State Legislators, City Mayors, County Road Advisors, Georgia DOT District Engineers and Training Officers, Federal Coordinators, Technology Transfer Centers, and others.

The mailing list is updated when changes in personnel are made available to the Center and also by request. During the summer of 1988, the mailing list was updated to exclude the names of the main officials in cities and counties, listing only their titles. These officials include mayor, county commission chairman, public works director, road superintendent, and county engineer. The purpose of this change in policy was to insure that when changes in personnel occur, the newsletter will continue to be received by the most appropriate person.

Workshop participants are encouraged to have their names added to the mailing list, and many do so. Twenty copies of the newsletter are sent to each District Office, Plus the downtown Atlanta Headquarter Office. In addition, GDOT employees who have requested a copy receive their own. A copy of the mailing list is included in Appendix A.

Publication List

A list of publications which are available from the Center’s library is maintained
on the IBM-PC. This list currently includes 354 publications and can be sorted by subject and author. The sort feature of the software facilitates a search for appropriate materials when requests are made by local agencies. Thirty-five publications were requested by local officials and were sent to them, free of charge. A listing of the publications currently available from the Center is contained in Appendix B.

**Video Tape Library**

The Center maintains a video tape library. At the present time, the Center has thirty-eight different VHS video tapes on topics ranging from tort liability to gravel roads. The tapes may be borrowed for a two-week period (requests are usually limited to two tapes at a time) and are loaned free of charge to anyone who requests them. Updates on available tapes are made in the newsletter. Certain titles are very popular, and a waiting list is maintained for the distribution of tapes which were unavailable at the time of the request. Fifty-one tapes have been loaned to local agencies during the year. A current listing of tapes available and their synopses is included in Appendix C.

**Workshops**

Workshops are the most important task of the Center's activities, in terms of both the quality and the quantity of access to the local agencies. Therefore, before a workshop is implemented, discussions are held with local officials, GDOT, FHWA, and others to evaluate topics of potential benefit to local agencies. The Policy Advisory Committee uses this information as well as returned questionnaires from previous workshops to determine which workshops should be scheduled and the locations for their presentations.
Workshop instructors are chosen from GDOT, FHWA, local agencies, and consultants. Most frequently, instructors are GDOT personnel.

The criteria used in making each of the above decisions are shown below:

<table>
<thead>
<tr>
<th>DECISION</th>
<th>CRITERIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workshop topic</td>
<td>- Potential benefits</td>
</tr>
<tr>
<td></td>
<td>- Needs</td>
</tr>
<tr>
<td></td>
<td>- Maximum participation</td>
</tr>
<tr>
<td>Duration</td>
<td>- Maximum participation</td>
</tr>
<tr>
<td></td>
<td>- Efficient coverage</td>
</tr>
<tr>
<td>Schedule</td>
<td>- Maximum participation</td>
</tr>
<tr>
<td>Instructors</td>
<td>- Knowledge of subject</td>
</tr>
<tr>
<td></td>
<td>- Understanding of local agency needs</td>
</tr>
<tr>
<td></td>
<td>- Cost</td>
</tr>
</tbody>
</table>

Using video tapes prepared by the International Road Federation and distributed by the Federal Highway Administration, the Technology Transfer Center has prepared four video workshop presentations. The four presentations are as follows:

- **Operator Daily Maintenance of Equipment**
- **Roadway Maintenance Procedures (Repair and Resurfacing Pavements)**
- **Maintenance Procedures for Bridges, Ditches, and Shoulders**
- **Roadway Maintenance Procedures for Unpaved Roads and Shoulders**

The consensus of the local agencies seemed to be that they felt a need for instruction in basic procedures in which their road crew could participate in at their own shop or nearby. Many highway workers cannot read, and are intimidated by the prospect of participating in a workshop with people other than their own crew. Also, due to manpower restrictions, most local agencies can only send a very select group of their crew to a remote workshop. The Center developed the four video workshops to
meet the expressed needs of the local agencies. All four workshops are half-day presentations. Video taped instruction is accompanied by oral instruction, discussion, and handouts. Booklets summarizing the video tapes are made available to foremen and supervisors, and have been given to GDOT under separate cover.

The presentations have been enthusiastically received by the participants, as well as local officials. The on-site presentations are perceived by the Center as an effective means of getting to know local personnel and their transportation needs better.

The Center conducted twenty-three workshops during the year. These include the video presentations as well as workshops coordinated with the Department of Transportation and the Federal Highway Administration. The following is a summary of workshop activity:

<table>
<thead>
<tr>
<th>WORKSHOP</th>
<th>PARTICIPANTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Relocation</td>
<td></td>
</tr>
<tr>
<td>Savannah</td>
<td>5/13</td>
</tr>
<tr>
<td>Jesup</td>
<td>5/10</td>
</tr>
<tr>
<td>Tifton</td>
<td>5/12</td>
</tr>
<tr>
<td>Thomaston</td>
<td>5/17</td>
</tr>
<tr>
<td>Tifton</td>
<td>5/18</td>
</tr>
<tr>
<td>Gainesville</td>
<td>5/24</td>
</tr>
<tr>
<td>Cartersville</td>
<td>5/26</td>
</tr>
<tr>
<td>Chamblee</td>
<td>5/3</td>
</tr>
<tr>
<td>Total</td>
<td>132</td>
</tr>
<tr>
<td>Business Moves/Decent, Safe, and Sanitary Housing</td>
<td></td>
</tr>
<tr>
<td>Thomaston</td>
<td>10/20</td>
</tr>
<tr>
<td>Gainesville</td>
<td>10/25</td>
</tr>
<tr>
<td>Chamblee</td>
<td>10/27</td>
</tr>
<tr>
<td>Total</td>
<td>61</td>
</tr>
<tr>
<td>Operator Daily Maintenance of Equipment</td>
<td></td>
</tr>
<tr>
<td>Columbia County</td>
<td>9/30</td>
</tr>
<tr>
<td>Douglas County</td>
<td>11/8</td>
</tr>
<tr>
<td>Total</td>
<td>58</td>
</tr>
</tbody>
</table>
Roadway Maintenance Procedures (Repair and Resurfacing Pavements)

<table>
<thead>
<tr>
<th>County</th>
<th>Date</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Columbia County</td>
<td>9/30</td>
<td>23</td>
</tr>
<tr>
<td>Rockdale County</td>
<td>10/4</td>
<td>22</td>
</tr>
<tr>
<td>Habersham County</td>
<td>10/7</td>
<td>28</td>
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<tr>
<td>Heard County</td>
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<td>24</td>
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<tr>
<td>Douglas County</td>
<td>10/25</td>
<td>35</td>
</tr>
<tr>
<td>Barrow County</td>
<td>11/1</td>
<td>18</td>
</tr>
<tr>
<td>Hall County</td>
<td>11/3</td>
<td>8</td>
</tr>
<tr>
<td>Murray County</td>
<td>10/18</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>162</td>
</tr>
</tbody>
</table>

Maintenance Procedures for Bridges, Ditches, and Shoulders

<table>
<thead>
<tr>
<th>County</th>
<th>Date</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Douglas County</td>
<td>11/8</td>
<td>35</td>
</tr>
</tbody>
</table>

Roadway Maintenance Procedures for Unpaved Roads and Shoulders

<table>
<thead>
<tr>
<th>County</th>
<th>Date</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Douglas County</td>
<td>11/8</td>
<td>35</td>
</tr>
</tbody>
</table>

Total number of sessions 23
Total number of participants 483

During 1987, the Technology Transfer Center instated the policy of charging a registration fee for participation in a workshop conducted at any of the Department of Transportation District Offices. The purpose of this fee is to assess the interest of the local agencies in the Center and to allow them to express their support through a token financial investment. The total dollars received for 1988 was $3,900.

Since, the video workshops presentations are a recent endeavor, a fee policy has not been established for them.

Newsletters (Tech Trans)

The newsletter is a very valuable tool for the Technology Transfer Center. It provides the opportunity to make local agencies aware of the services which are available through the Center, as well as other programs throughout the Southeast. In
addition, the newsletter is a channel for the actual transfer of technology to the local agencies, with pertinent information on new methods and trends.

Tech Trans was published each quarter of 1988, and approximately 2500 copies of the newsletter were distributed each quarter. Total distribution was increased 15% over 1987.

Contents of each newsletter may include the following:

- Editor's Note: This column is devoted to informing the readers about what is happening at the Center. Policy and personnel changes are noted here, as well as highlighting upcoming events.

- Articles: Each newsletter contains two or more articles. Articles come from various sources and are chosen for their applicability to the needs of the local agencies in the State.

- Maintenance Tips: Maintenance tips are selected from the "Field Maintenance Manual for Georgia Counties Local Roads and Streets."

- Briefs, Trends, and Facts: On the lighter side, several short, news-worthy topics are published. Some of the items included under this heading are: historical facts, miscellaneous trends, general transportation related news, financial data, and humorous items.

- Publications: Research reports and relevant articles are listed in the newsletter. These may be publications which are available from the Center at no charge or which may be ordered from other agencies. Video tapes are also included.

- Workshops and Conferences: A selective list of upcoming meetings, workshops, etc., concerning relevant topics, are listed so that the local agencies will be aware of such opportunities.

Technical Assistance

The Center has during the past year responded to 74 requests for technical assistance. Requests for assistance are made during workshops, by telephone, or by mail. Typical areas of technical assistance provided were in microcomputer applications in transportation, roadway surface treatment, signalized intersection analysis, and traffic
control and operations. Responses to these requests are provided by telephone, by mail, or by on-site visits.

In addition, the Center has worked very closely with GDOT, Bureau of Public Transportation. The Center has provided microcomputer assistance in the form of purchase specifications, installation and operation to all of the urban area transit agencies, except MARTA.
EVALUATION

Throughout the summer of 1988, the Georgia Department of Transportation was in the process of evaluating the work of the Technology Transfer Center for the purpose of making a decision as to the continuation of funding for the project. A survey questionnaire was distributed by Mr. Hal Rives, Commissioner, to the Chairmen of the County Commissions. The various chairmen were requested to distribute the questionnaire to appropriate city people in their county.

The results of the survey were compiled in a report which was generated on August 24, 1988 by the Materials and Research Laboratory. (A copy of the report is included in Appendix E.) Forty-eight percent of the counties in Georgia responded to the survey. In some counties, more than one questionnaire was returned for a total of 87 responses. Of the 87 responses, 66 indicated that they thought the Technology Transfer Center should be continued, 10 were neutral, and 11 indicated that they did not think they program should be continued.

The eleven negative responses can be further examined, with interesting results. Three of the respondees who indicated that they did not think the program should be continued, also indicated that they had used the services of the Center and found them to be of value. Six of the negative responses indicated that the services of the Center had never been utilized by their agency. Only two agency who indicated that the program should be discontinued had used the services of the Technology Transfer Center and found them to be of no value. One can draw the conclusion that the Center is not inadequate but under-advertised.
Respondees gave an overwhelming indication that they saw the need for workshops that could be conducted at the local agency's shop, and that they would support such an activity. The Center has already responded to this need with the establishment of four video presentations. The topics of the presentations are ones which the respondees indicated to be relevant to their needs.
CONCLUSION

"...no way to tell you what this service means to us."

"It's a real good service. We would like to see it continued."

"My crew has never had the opportunity to attend workshops other than those offered by the Technology Transfer Center."

"Everyone in our office was afraid to use computers until they went to the workshop..."

"John is invaluable as a ready source of technical assistance."

"We were trying to work with no traffic data at all, until we started borrowing the traffic counters from the Center."

"...the training and technical assistance is a viable tool...the Center is very much needed to assist our road and engineering department in several critical areas."

"really helps the 'little man'..."

"...the Center was more willing to meet our needs on our schedule..."

There were several telephone follow-up of Mr. Rives' Technology Transfer Center Evaluation Questionnaire. The purpose of the telephone follow-up was to obtain specific information as to how the Center had increased productivity in local agencies. The responses are summarized into general categories.

The workshops sponsored by the T² Center are seen as a viable means to obtain basic information on everyday operations. "Basic", is used here to mean information that may not be technologically earth-shattering, but to which the local agency has no other access. In conversations with local officials, phrases such as "don't have to re-invent the wheel" were frequently used regarding the information obtained through T² workshops. Commonly made errors in practice or judgement can be avoided with
minimal instruction; it seems that the process of developing effective techniques through trial and error is often shortened or eliminated because of information made available to the people who really need to know.

Regarding the "people who really need to know," it was pointed out several times that the Center is frequently the only source that is available to the actual road crew. Engineers, officials, and office personnel may have some options as to where they can turn for information, depending on the availability of time and money; but it is seldom that anyone has anything to offer the road crew, even if they could all be spared to attend a workshop.

As previously mentioned, the information available from the Center is not necessarily hi-tech or radical. It is frequently information that is readily available to the public—if they knew where to look and had the time and inclination to spend looking. The T² Center is viewed by local agencies as a clearinghouse for all sorts of information, obtainable through a single telephone call. They consider the T² staff their transportation "yellow pages" for information as well as advice. These views are a summary of the responses that were elicited by the question, "In what specific ways has the Technology Transfer Center increased productivity in your agency?"

One response in particular should be shared in more detail. Mr. Don Bartles, Columbia County Public Works Director, was more than eager to relate all of the ways that the Center had benefitted his county. One thing that he was especially excited about was the new program using calcium chloride on unpaved roads. He had called Dr. John Moskaluk about a year ago to ask for suggestions on dust control. Dr. Moskaluk did some checking around and put him in touch with a company in Canada
that manufactured the product that Mr. Bartles needed. Columbia County now has some very ridable dirt roads. Mr. Bartles said that some of the people in Columbia County are enjoying their dirt roads so much, "they would fight you if you tried to pave those roads." The landfill road was an especial nuisance, but they have not had any complaints since they started treating it with calcium chloride. Partially to be helpful and partially to try to lower his own costs, Mr. Bartles sold the program to officials in McDuffie, Warren, Lincoln, and White counties. The market proved to be so good that the manufacturer now has offices in Columbia County. Mr. Bartles credits the Georgia Tech Technology Transfer Center with this whole operation. As if this story were not praise enough, Mr. Bartles went on to relate how 250 miles of dirt road in Columbia County had been rated as a result of his attendance at the T2 workshop concerning the NACE manual and guides. Having rated their dirt roads, officials in Columbia County are now able to prioritize their entire road system. Therefore, they are able to validate their requests for assistance from the Department of Transportation in paving concerns.

The final result of these and other improvements in Columbia County is that they do not "bother the Commissioner's office as much." Columbia County, as a result of assistance from the Technology Transfer Center, is better educated and better able to take care of their roads in a timely and efficient manner.

Obviously, not every public works director in Georgia is this enthusiastic about the Technology Transfer Center. However, this example is one which illustrate how the whole spectrum of service offered by the Center can be utilized by local agencies.

In summary, the center has established itself as a valid and useful entity from which local transportation agencies can receive assistance. Based on a complex decision
process, the GDOT has determined that future Center activities should be continued by the Department. Although the partnership of GDOT and Georgia Tech provided an additional facet of expertise, it is anticipated that the GDOT will continue many similar activities and build upon the foundation laid by the Georgia Tech Technology Transfer Center.

Many local agencies success stories (in terms of improved productivity and increased efficiency) can be attributed to the Georgia Tech Center. A technology transfer center is for the benefit of the cities and counties throughout the State. A successful program is dependent on their utilization of the services provided by the Center. It is hoped that the local agencies will continue to use the new center at GDOT.
APPENDIX A—Mailing List
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<td>District 57 Post 2</td>
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<td>BILL VERWEB</td>
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GERALD BALAS
POLICE CHIEF
4470 MARIETTA ST.
POWDER SPRINGS, GA 30073

MAYOR
CITY ADMINISTRATOR
617 ATLANTA ST.
CITY HALL
ROSWELL, GA 30075

CITY ENGINEER
617 ATLANTA ST.
CITY HALL
ROSWELL, GA 30075

P. C. WINGLERDOEFF
CITY OF ROSWELL
150 DOBBS DR.
ROSWELL, GA 30075

REGINA APPLING
CITY OF ROSWELL
150 DOBBS DRIVE
ROSWELL, GA 30075

POLICE CHIEF
100 MOUNTAIN PASS RD.
ROSWELL, GA 30075

SUSIE C. BRASLEY
CITY OF ROSWELL
150 DOBBS DRIVE
ROSWELL, GA 30075

DENNIS MILLER
CITY OF ROSWELL ENG. DEPT.
150 DOBBS DR.
ROSWELL, GA 30075

HON. LUTHER COLBERT
DISTRICT 23
455 ROUSE WAY
ROSWELL, GA 30076

SUSAN HAYES
CITY HALL
ROSWELL, GA 30075

CITY HALL
CITY HALL
ROSWELL, GA 30075

CITY ENGINEER
STREET SUPERINTENDENT
617 ATLANTA ST.
CITY HALL
ROSWELL, GA 30075

PUBLIC WORKS SUPERINTENDENT
P. O. BOX 1226
SNYERTA, GA 30080

HON. WILLIAM ATKINS
DISTRICT 21 POST 3
4719 WINDSOR DR.
SNYERTA, GA 30080

E. E. LITTLE
POLICE CHIEF
1286 BANK ST. S.E.
SNYERTA, GA 30081

CITY ENGINEER
CITY MANAGER
CITY OF SNYERTA
P. O. BOX 1226
SNYERTA, GA 30081

ROBERT LAWRENCE STUNBAUGH
TRUCKING DIRECTOR
1010 TANASSEE TR.
STONE MOUNTAIN, GA 30083

DANIEL HAZIM
PROJECTS DIRECTOR
STAINING ENTERPRISES
2022 WENNS ROAD
TUCKER, GA 30084

HON. THOMAS LAWRENCE
DISTRICT 45
2283 STRATMOR DR.
STONE MOUNTAIN, GA 30087

MAYOR
PUBLIC WORKS SUPERINTENDENT
CITY HALL
P. O. BOX 454
STONE MOUNTAIN, GA 30086

HON. R. T. PHILLIPS
DISTRICT 9
1703 POUNDS RD.
STONE MOUNTAIN, GA 30087

CINDY GENTRY
RIGHT-OF-WAY AGENT
COBB COUNTY DOT
10 E. PARK SQUARE
ROOM 410
MARIETTA, GA 30060-3612

MR. FRED K. BENTLEY
CONSTRUCTION ENGINEER
COBB COUNTY DOT
10 E PARK SQUARE
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E. BENSON CHAMBERS
COUNTY ATTORNEY
CHEROKEE COUNTY
P. O. BOX 705
CANTON, GA 30114

TRAFFIC ENGINEER
CARROLL COUNTY
P. O. BOX 338
CARROLLTON, GA 30117

RAY ADAMS
ELECTRIC MEMBERSHIP CORP
153 TEMPLE RD.
P. O. BOX 529
CARROLLTON, GA 30117

H. T. JOHNSON III
W. GEORGIA AREA OFFICE
GEORGIA TECH
101 TANNER STREET
P. O. BOX 676
CARROLLTON, GA 30117

SKIP WELCH
PROGRAMS COORDINATOR
CITY OF CARROLLTON
P. O. BOX 1246
CARROLLTON, GA 30117

ROAD SUPERINTENDENT
CARROLL CO.
P. O. BOX 338
CARROLLTON, GA 30117

CITY OF CARROLLTON
P. O. BOX 1246
CARROLLTON, GA 30117

GERALD GILREATH
CARROLL COUNTY TRAFFIC ENG. DEPT.
512 OLD NEWNAN ROAD
CARROLLTON, GA 30117

HON. NEWT GINGRICH
6TH DISTRICT REPRESENTATIVE
CARROLL COUNTY COURTHOUSE
CARROLLTON, GA 30117

HON. WAYNE GARNER
DISTRICT 50
109 STONEWALL DR.
CARROLLTON, GA 30117

HON. JOHN SIMPSON
DISTRICT 7A
102-A NEWNAN ST.
CARROLLTON, GA 30117

MR. FELTON RUTLEDGE
DISTRICT ENGINEER
GDOT DISTRICT 6
U.S. 41 SOUTH
P. O. BOX 10
CARTERSVILLE, GA 30120

TERRY HABERS
GDOT DISTRICT 6
U.S. 41 SOUTH
P. O. BOX 10
CARTERSVILLE, GA 30120

CHAIRMAN
CARROLL CO. COMM.
P. O. BOX 338
CARROLLTON, GA 30117

CITY MANAGER
P. O. BOX 529
CARTERSVILLE, GA 30120

HON. BOYD PETTIT III
DISTRICT 19
P. O. BOX 1256
CARTERSVILLE, GA 30120

MR. HUGH BRADLEY
121 GARRIZX DRIVE
CARTERSVILLE, GA 30120

RAY SOUTHEEN
CITY OF CARTERSVILLE
P. O. BOX 548
CARTERSVILLE, GA 30120

CO. ROAD SUPERINTENDENT
BUTTS COUNTY
COUNTY COURTHOUSE
JACKSON, GA 30122

MR. RAY SOUTHERN
CITY OF CARTERSVILLE
P. O. BOX 365
CARTERSVILLE, GA 30120

HOMALD GARLAND
438 GRASSDALE ROAD
CARTERSVILLE, GA 30120

CO. ROAD SUPERINTENDENT
POLE COUNTY
COURTHOUSE
CEDARTOWN, GA 30125

STREET SUPERINTENDENT
P. O. BOX 365
CAVE SPRING, GA 30124

MAJOR
P. O. BOX 365
CAVE SPRING, GA 30124

CHAIRMAN
COUNTY COMMISSIONERS
POLE COUNTY
COURTHOUSE
CEDARTOWN, GA 30125

STREET SUPERINTENDENT
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MAYOR
P.O. BOX 36
BYRONVILLE, GA 31007

ENGINEER MAYOR
P.O. BOX 36
BYRONVILLE, GA 31007

STREET SUPERINTENDENT
COCHRAHAM, GA 31014

CITY ENGINEER
P.O. BOX 8
COCHRAHAM, GA 31014

CHAIRMAN
CRISP CO. COMM.
P.O. BOX 188
COCHRABE, GA 31015

MAYOR
P.O. BOX 569
COCHRABE, GA 31015

PUBLIC WORKS SUPT.
P.O. BOX 38
CULLODEN, GA 31016

MAYOR
P.O. BOX 157
DANVILLE, GA 31017

COUNTY ENGINEER
LUMBERT COUNTY
P.O. BOX 119 SOPERTON AVE.
EAST DUBLIN, GA 31021

MAYOR
P.O. BOX 135
BUDGET, GA 31022

COUNTY ENGINEER
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BON. DAVID LUCAS  
DISTRICT 102  
446 WOOLFOLK ST.  
MACON, GA 31201

MAJNARD WYNN  
BIBB CO. ENGINEERING DEPT.  
BIBB CO. COURTHOUSE  
MACON, GA 31201

HON. WILLIAM RANDALL  
DISTRICT 101  
P.O. BOX 121  
MACON, GA 31202

HON. J. BOY BROWLAND  
US REP 8TH DIST  
P.O. BOX 6155  
MACON, GA 31208

SOT. ALLEN BUSBEE  
BIBB CO. SHERIFF DEPT.  
728 WIMBISH ROAD  
MACON, GA 31210

HON. J. BOY BROWLAND  
US REP 8TH DIST  
P.O. BOX 6155  
MACON, GA 31208

ALICE L. ROBERTS  
ECONOMIC & COMMUNITY  
DEVELOPMENT DEPT.  
713 SOUTHERN TRUST BUILDING  
MACON, GA 31201

LINDA HAMPTON  
SERVICES DIRECTOR  
OLDER AMERICANS COUNCIL OF  
MIDDLE GEORGIA  
P.O. BOX 8766  
MACON, GA 31208

WALTER R. CENTER  
OPERATIONS OFFICER  
BIBB COUNTY  
4526 KNIGHT RD.  
MACON, GA 31210

R. J. ROY ROWLAND  
HON. FRANK PINKSTON  
HON. FLOYD M. BUFORD JR.  
US REP 8TH DIST  
DISTRICT 100  
DISTRICT 103  
P.O. BOX 4872  
P.O. BOX 13183  
P.O. BOX 6258  
P.O. BOX 4872  
P.O. BOX 13183  
P.O. BOX 6258

HON. TOMMY C. OLMLSTEAD  
DISTRICT 26  
P.O. BOX 5129  
MACON, GA 31298

STEPHEN V. SKALKO  
BUREAU OF INSPS. & FEES  
P.O. BOX 247  
MACON, GA 31258

CO. ROAD SUPERINTENDENT  
MCINTOSH COUNTY  
COURTHOUSE  
P.O. BOX 584  
DARIEN, GA 31305

MAYOR  
P.O. BOX 513  
CITY HALL  
DARIEN, GA 31305

CO. ROAD SUPERINTENDENT  
P.O. BOX 513  
CITY HALL  
DARIEN, GA 31305

COUNTY ENGINEER  
LIBERTY COUNTY  
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Note: The above table represents the names and addresses of various officials from different counties in Georgia. The information includes positions such as Chairman, Mayor, County Administrator, and Public Works Director. The addresses are primarily located in Cairo, GA 31728.
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<td>Jeffrey Haber</td>
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<td>Thomas Sobel</td>
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</table>

**Additional Contacts:**

- Debra Rood (Institute Traffic Safety Mgt. & ESS, 250 Washington Ave., Albany, NY 12210)
- Peter Naccarato (Highway Superintendent, Town of Hurley, P.O. Box 302, Hurley, NY 12443)
- Richard J. Brown (Executive Secretary, MTS Asso. of Town Supt., 4294 Chams Mills Road, Truxton, NY 13156)
- William C. Hayes (County Highway Supt., State Route 23 Highway Dept., 117 E. Stuerb Street, Bath, NY 14810)
- Daryl Haasley (Director, Northeast Ed Center, 104 Weaver Bldg., University Park, PA 16802)
- William J. Pogash (Penn. Dept. of Trans., Room 1207 Trans. & Safety Bldg., Harrisburg, PA 17120)
- Wade L. Gramling (Associate Director, Office of Res. & Sp. Stud. PA Dept. of Transportation, 905 Trans. & Safety Bldg., Harrisburg, PA 17120)
- Cynthia Swatek (Special Studies Analyst, Pennsylvania DOT, Room 505 Trans. & Safety Bldg., Harrisburg, PA 17120)
- Barbara T. Hardre (Director, Office of Res. & Spec. Stud. PA DOT, Room 205 Trans. & Safety Bldg., Harrisburg, PA 17120)
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<td>DIV. OF LOCAL ASSISTANCE</td>
<td>INDIANA DEPT. OF HWYS.</td>
<td>100 NORTH SENATE AVENUE</td>
<td>INDIANAPOLIS</td>
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<td>MR. BARRY PARTRIDGE</td>
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<td>Clay Castleberry</td>
<td>T2 Coordinator</td>
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<td>10 Serra Monte Drive, Oroville, CA 95966</td>
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<td>Caleb Frobig</td>
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<td>Mr. E. S. Coulter</td>
<td>State Highway Engineer</td>
<td>Oregon State Hw Division</td>
<td>Room 140</td>
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<tr>
<td>Mr. R. S. Coulter</td>
<td>State Highway Engineer</td>
<td>Oregon State Hw Division</td>
<td>Room 140</td>
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<td>George Gamota</td>
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<td>University of Michigan</td>
<td>Ann Arbor, MI 98109</td>
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<tr>
<td>Dr. Ernest Geissler</td>
<td>Director</td>
<td>County Road ADM. Board</td>
<td>6730 Martin Way N.E., Olympia, WA 98504</td>
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<tr>
<td>Mr. Kenneth Durree</td>
<td>Center for Urban Studies</td>
<td>Portland State University</td>
<td>Portland, OR 97202</td>
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<td>W. J. Quinn</td>
<td>Oregon T2 Center</td>
<td>Dept. of Transp. Research</td>
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<td>W. J. Quinn</td>
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<td>Dept. of Transp. Research</td>
<td>800 Airport Rd.</td>
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<td>Dept. of Transp. Research</td>
<td>800 Airport Rd.</td>
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<td>Wes Heidenreich</td>
<td>Coordinator</td>
<td>Oregon T2 Center</td>
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<tr>
<td>Dr. Robert Lattow</td>
<td>Director</td>
<td>Trans. Research Ins.</td>
<td>Oregon State University</td>
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<td>Mr. David Rawley</td>
<td>Director</td>
<td>Federal Hw. Admin.</td>
<td>Evergreen Plaza</td>
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<td>Dr. Robert Lattow</td>
<td>Director</td>
<td>Trans. Research Ins.</td>
<td>711 S. Capitol Way</td>
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<td>Mr. Barry B. Brecto</td>
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<tr>
<td>Mr. John D. Martin</td>
<td>Executive Committee</td>
<td>Alaska Dept. of Transportation</td>
<td>2201 Foger Rd.</td>
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<tr>
<td>Mr. John D. Martin</td>
<td>Executive Committee</td>
<td>Alaska Dept. of Transportation</td>
<td>2201 Foger Rd.</td>
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APPENDIX B--Publication List
Entries for the publication list are followed by three sort codes, agency, subject, and newsletter. A listing of the agency and subject codes follows. The newsletter code option is no longer maintained and should be disregarded when reviewing the publication list.

AGENCY CODES

1. UMTA
2. NHTSA
3. MATERIALS RESEARCH BOARD
4. RESEARCH & SPECIAL PROGRAMS ADMINISTRATION
5. AIRPORT GROUND TRANSPORT ASSOCIATION
6. FHWA
7. GEORGIA TECH
8. HERPICC--PURDUE UNIVERSITY
9. FRA
10. USDA
11. GEORGIA OFFICE OF HIGHWAY SAFETY
12. KANSAS DOT
13. S. E. TRUSS MANAGEMENT ASSOCIATION
14. FEDERAL EMERGENCY MANAGEMENT ADMINISTRATION
15. GDOT
16. PENNSYLVANIA DOT
17. URBAN CONSORTIUM
18. TRB
19. UNIVERSITY OF CALIFORNIA
20. MILITARY TRAFFIC MANAGEMENT COMMAND
21. U. S. ARMY CORPS OF ENGINEERS
22. NASA
23. ALABAMA T2 CENTER
24. USDOT
25. OTHER
26. APWA

SUBJECT CODES

1. MASS TRANSIT--PLANNING & SYSTEMS
2. SAFETY
3. HAZARDOUS WASTES
4. TRANSPORTATION INFORMATION
5. AIRPORTS
6. ASPHALT PAVEMENTS
7. SWAMP USAGE
8. MANAGEMENT
9. TRAINING
10. TRAFFIC SIGNALS, ENGINEERING
11. CONSTRUCTION MACHINERY
12. BRIDGES
13. DRAINAGE
14. CONCRETE MARKING
15. DUST CONTROL
16. PAVEMENT MARKING
17. RESEARCH & DEVELOPMENT
18. SOILS
19. MAINTENANCE
20. PARKING
21. ENERGY
22. ROADS
23. PEDESTRIANS, ELDERLY & HANDICAPPED
24. STATISTICS & BIBLIOGRAPHIES
25. STEEL
26. FINANCING
27. HIGHWAY--GENERAL
28. REGULATIONS & SPECIFICATIONS
29. ENVIRONMENT
30. TORT LIABILITY
31. HYDROLOGY
32. COMPUTERS, HARDWARE, ETC.
33. FREIGHT TRANSPORTATION
34. ALCOHOL
35. OTHER
A BASIC ASPHALT EMULSION MANUAL
- THE ASPHALT INSTITUTE, 1980 115+ BOX
  Agency - 6  Subject - 6  Newsletter - 9

ACCELERATED RECOVERY OF NATIVE VEGETATION ON ROADWAY SLOPES FOLLOWING CONSTRUCTION VOL. I
- FHWA, 1987 67+ 1
  Agency - 6  Subject - 29  Newsletter - 0

ACCELERATED RECOVERY OF NATIVE VEGETATION ON ROADWAY SLOPES FOLLOWING CONSTRUCTION VOL. II
- FHWA, 1987 103 1
  Agency - 6  Subject - 29  Newsletter - 0

ACCELERATED RECOVERY OF NATIVE VEGETATION ON ROADWAY SLOPES FOLLOWING CONSTRUCTION VOL. III
- FHWA, 1987 26 1
  Agency - 6  Subject - 29  Newsletter - 0

ACCESS: BROKERING PARATRANSIT SERVICES TO THE ELDERLY AND HANDICAPPED IN ALLEGHENY COUNTY PA
- UMTA, 1984 162+ 1
  Agency - 1  Subject - 23  Newsletter - 0

ACCIDENT RESEARCH MANUAL
- FHWA, 1980 136 1
  Agency - 6  Subject - 2  Newsletter - 0

ACCOUNTING WITH LOTUS 1-2-3
- WADSWORTH, 1983 276 1
  Agency - 28  Subject - 32  Newsletter - 0

ADDRESSING ORGANIZATIONAL ISSUES SELECTED READINGS VOLUME 3
- USDOT, 1984 93 1
  Agency - 24  Subject - 35  Newsletter - 0

A DIGEST OF STATE ALCOHOL-HIGHWAY SAFETY RELATED LEGISLATION
- NHTSA, 1983 312 3
  Agency - 2  Subject - 2  Newsletter - 0

ADMINISTRATION AND MANAGEMENT OF LOCAL STREETS AND ROADS VOLUME I
- HERPICC, 1988 200 1
  Agency - 8  Subject - 8  Newsletter - 0
ADMINISTRATION AND MANAGEMENT OF LOCAL STREETS AND ROADS VOLUME II
- HERPICC, 1988 200 1
  Agency - 8  Subject - 8  Newsletter - 0

A GUIDE FOR USERS
- UMTA, 1984 26 1
  Agency - 1  Subject - 1  Newsletter - 7

A GUIDE TO SELF SUFFICIENT FUNDING OF ALCOHOL TRAFFIC SAFETY PROGRAMS
- NHTSA, 1983 46 1
  Agency - 2  Subject - 34  Newsletter - 0

A GUIDE TO THE FEDERAL HAZARDOUS MATERIALS TRANSPORTATION REGULATORY PROGRAM
- MTB, 1983 53 1
  Agency - 3  Subject - 3  Newsletter - 0

A GUIDE TO THE USE OF DISSEMINATION TECHNIQUES FOR TRANSPORTATION INFORMATION
- RSPA, 1983 146+ 2
  Agency - 4  Subject - 4  Newsletter - 0

AIRPORT GROUND TRANSPORTATION: PROBLEMS AND SOLUTIONS
- AGTA, 1981 155+ 1
  Agency - 5  Subject - 5  Newsletter - 0

ALTERNATE HIGHWAY DEICING CHEMICALS
- FHWA, 1980 16+ 1
  Agency - 6  Subject - 6  Newsletter - 0

ALTERNATIVE FINANCING FOR URBAN TRANSPORTATION
- USDOT, 1986 135 1
  Agency - 24  Subject - 4  Newsletter - 0

AMERICA RUNS ON LOCAL ROADS
- LOCAL ROAD USERS, 1986 29 11
  Agency - 30  Subject - 27  Newsletter - 0

A METHOD FOR WETLAND FUNCTIONAL ASSESSMENT VOL.1
- FHWA, 1983 125+ 1
  Agency - 6  Subject - 7  Newsletter - 3
A METHOD FOR WETLAND FUNCTIONAL ASSESSMENT VOL. 2
- FHWA, 1983 120+ 1
  Agency - 6 Subject - 7 Newsletter - 3

ANALYSIS OF COMMUTER RAIL COSTS AND COST ALLOCATION METHODS
- UMTA, 1983 90+ 1
  Agency - 1 Subject - 1 Newsletter - 0

ANALYSIS OF JOINTED CONCRETE PAVEMENTS
- FHWA, 1986 68 1
  Agency - 6 Subject - 14 Newsletter - 0

ANNOTATED BIBLIOGRAPHY FOR TRANSPORTATION PLANNING IN SMALL AND MEDIUM-SIZED COMMUNITIES
- TRB, 1984 22 1
  Agency - 18 Subject - 24 Newsletter - 0

A PAVEMENT MOISTURE ACCELERATED DISTRESS (MAD) IDENTIFICATION SYSTEM VOL. 1
- FHWA, 1981 135+ 1
  Agency - 6 Subject - 6 Newsletter - 0

A PAVEMENT MOISTURE ACCELERATED DISTRESS (MAD) IDENTIFICATION SYSTEM VOL. 2
- FHWA, 1981 227+ 1
  Agency - 6 Subject - 6 Newsletter - 0

APPLICATION OF ADHESIVES TO STEEL BRIDGES
- FHWA, 1984 176 1
  Agency - 6 Subject - 12 Newsletter - 0

A PREVENTIVE MAINTENANCE MANAGEMENT SYSTEM FOR LOCAL GOVERNMENTS
- GA TECH, 1982 30+ 1
  Agency - 7 Subject - 8 Newsletter - 0

A PROCEDURE FOR DETERMINING FREQUENCIES TO INSPECT AND REPAIR HIGHWAY SAFETY HARDWARE
- FHWA, 1983 17+ 2
  Agency - 6 Subject - 2 Newsletter - 8

ARTERIAL ANALYSIS PACKAGE (AAP)
- FHWA, 1987 150+ 1
  Agency - 6 Subject - 10 Newsletter - 0
ASSESSMENT OF THE IMPACTS OF THE NATIONAL FLOOD INSURANCE PROGRAM ON HIGHWAYS
- FHWA, 1980 67 1
  Agency - 6  Subject - 13  Newsletter - 0

A TRAINING GUIDE FOR PAVEMENT MAINTENANCE PERSONNEL
- HERPICC PURDUE UNIV, 1983 42 2
  Agency - 8  Subject - 9  Newsletter - 6

AUDIOVISUAL CATALOG FHWA REGION 4
- FHWA, 1988 78 1
  Agency - 6  Subject - 24  Newsletter - 0

BARRIERS TO PRIVATE SECTOR PARTICIPATION IN PUBLIC TRANSPORTATION
- USDOT, 1995 48+ 1
  Agency - 24  Subject - 26  Newsletter - 0

BRIDGE FORMULA APPLICATION VOL. I
- FHWA, 1984 71 1
  Agency - 6  Subject - 12  Newsletter - 0

BUS ROUTE DEMAND MODELS
- SG ASS. INC BOSTON, 1983 109 SET OF 3
  Agency - 1  Subject - 1  Newsletter - 0

BY LAND SEA AND AIR
- GEORGIANS FOR BETTER TRANSPORTATION, 1983 30 1
  Agency - 30  Subject - 4  Newsletter - 0

CALIFORNIA FLEXIBLE PAVEMENT MANAGEMENT SYSTEM THE DRIVER: MAIN PROGRAM
- FHWA, 1980 80 1
  Agency - 6  Subject - 19  Newsletter - 0

CANDIDATE SIGNAL WARRANTS FROM GAP DATA
- FHWA, 1983 73 1
  Agency - 6  Subject - 10  Newsletter - 0

CASE STUDIES USING EAROMAR
- FHWA-TS-84-219
  - FHWA, 1984 160 1
    Agency - 6  Subject - 19  Newsletter - 9
CATALOG OF MAINTENANCE SAFETY/TRAINING & GENERAL INFORMATION VIDEO TAPE
- MINNESOTA DOT, 1986 42 1
  Agency - 6  Subject - 24  Newsletter - 0

CATALOG OF RESEARCH STUDIES AND REPORTS
- TEXAS COOPERATIVE HIGHWAY RESEARCH PROGRAM, 1988 228 1
  Agency - 30  Subject - 24  Newsletter - 0

CASE STUDIES IN RURAL TRANSPORTATION RESOURCE MANAGEMENT
- USDOT, 1984 74 2
  Agency - 24  Subject - 8  Newsletter - 0

CAUSES OF RISING TRANSIT OPERATING DEFICITS
- USDOT, 1983 143 1
  Agency - 24  Subject - 1  Newsletter - 0

CENTRIFUGAL TESTING OF MODEL PILES AND PILE GROUPS
- FHWA, 1984 43 1
  Agency - 6  Subject - 35  Newsletter - 0

CHECKLIST FOR PREPARING BASIC MOTOR GRADER (29000 LBS. CLASS) SPECIFICATIONS
- PURDUE UNIV, 1983 8 1
  Agency - 8  Subject - 11  Newsletter - 0

COMMUNITY MODEL FOR HANDLING HAZARDOUS MATERIAL TRANSPORTATION EMERGENCIES EXECUTIVE SUMMARIES
- USDOT, 1986 150 1
  Agency - 24  Subject - 3  Newsletter - 0

COMMUTER AND EXPRESS BUS SERVICE IN THE SCAG REGION
- SCAG TRANSIT SECTION, 1982 58+ 1
  Agency - 1  Subject - 1  Newsletter - 0

COMPARISON OF THREE COMPACTORS USED IN POTHOLE REPAIR
- COLD REGIONS LAB, 1984 14 1
  Agency - 6  Subject - 21  Newsletter - 0

COMPILATION OF STATE LAWS AND REGULATIONS ON MATTERS AFFECTING RAIL HIGHWAY CROSSINGS
- ASSOC. OF AMER RR, 1983 425+ 1
  Agency - 9  Subject - 2  Newsletter - 4
COMPUTERIZED SIGNAL SYSTEMS: OVERVIEW AND PRODUCT SUMMARIES  
- FHWA, 1982 100+ 1  
  Agency - 6 Subject - 10 Newsletter - 0

CONNECTIONS FOR MODULAR PRECAST CONCRETE BRIDGE DECKS  
- THE CONSULTING ENGINEERS GROUP INC. IL, 1983 107+ 1  
  Agency - 6 Subject - 12 Newsletter - 0

COORDINATION OF TRANSPORTATION RESOURCES THE GEORGIA EXPERIENCE  
- GDOT, 1985 17 1  
  Agency - 16 Subject - 4 Newsletter - 0

CORRIDOR TRANSPORTATION MANAGEMENT FOR HIGHWAY RECONSTRUCTION  
- USDOT, 1986 182 1  
  Agency - 24 Subject - 8 Newsletter - 0

COSMIC SOFTWARE CATALOG  
- NASA, 1984 350 1  
  Agency - 32 Subject - 22 Newsletter - 0

COUNTY STORM DRAINAGE MANUAL  
- PURDUE UNIV, 1981 300+ 2  
  Agency - 8 Subject - 13 Newsletter - 0

CULVERT INSPECTION MANUAL  
- FHWA, 1986 205 2  
  Agency - 6 Subject - 13 Newsletter - 0

DECAY IN WOOD BRIDGES  
- CLARK AND ESLYN USDA, 1983 49+ 1  
  Agency - 10 Subject - 12 Newsletter - 4

DECISION PROCEDURES IN TRANSIT STATION DESIGN  
- UNIV OF VIRGINIA, 1981 59 1  
  Agency - 4 Subject - 1 Newsletter - 0

DEMAND RESPONSIVE APPROACH TO HIGHWAY MAINTENANCE AND REHABILITATION--VOL. 1: DEVELOPMENT OF CONCEPTS AND EXAMPLES  
- USDOT, 1987 59 1  
  Agency - 24 Subject - 19 Newsletter - 0
DESCRIPTIONS OF TRANSIT MAINTENANCE MANAGEMENT INFORMATION SYSTEMS UMTA
- , 1984 277 1
  Agency - 1  Subject - 1  Newsletter - 0

DESIGN AND CONSTRUCTION OF THE LINN COVE VIADUCT
- FHWA , 1984 133 1
  Agency - 6  Subject - 12  Newsletter - 0

DESIGN EXAMPLES FOR STEEL BOX GIRDER S
- FHWA , 1986 50 1
  Agency - 6  Subject - 35  Newsletter - 0

DESIGN GUIDELINES FOR RAISED AND TRAVERSABLE MEDIANS IN URBAN AREAS
- UNIV OF VA AND VADOT , 1983 44+ 1
  Agency - 27  Subject - 22  Newsletter - 0

DETERMINATION OF PEAK DISCHARGE AND DESIGN HYDROGRAPHS FOR SMALL WATERSHEDS IN INDIANA
- PURDUE UNIV , 1964 106 1
  Agency - 8  Subject - 13  Newsletter - 0

DEVELOPMENT AND APPLICATION OF TRIP GENERATION RATES
- FHWA , 1985 46+ 3
  Agency - 6  Subject - 10  Newsletter - 0

DEVELOPMENT OF A HIGH PRESSURE WATER JET FOR THE RAPID REMOVAL OF CONCRETE
- DAEDALEAN ASS INC. MD, 1983 52+ 1
  Agency - 6  Subject - 14  Newsletter - 0

DEVELOPMENT OF A MAINTENANCE MANAGEMENT SYSTEM FOR GA COUNTIES
- UNIV GA , 1975 59 1
  Agency - 11  Subject - 8  Newsletter - 0

DEVELOPMENT OF THE CALIFORNIA PAVEMENT MANAGEMENT SYSTEM VOL.1
- CA DOT , 1978 198+ 2
  Agency - 6  Subject - 6  Newsletter - 0

DEVELOPMENT OF THE CALIFORNIA PAVEMENT MANAGEMENT SYSTEM VOL.2
- CA DOT , 1978 59 1
  Agency - 6  Subject - 6  Newsletter - 0
DIAMOND INTERCHANGE PROGRAM
USERS MANUAL
- CALTRANS , 1980 80+ 2
  Agency - 6  Subject - 10  Newsletter - 0

DIGEST OF INFORMATION ON
SUPER WATER REDUCERS
- EXPERIMENTAL PROJECTS PROGRAM , 1984 21 1
  Agency - 14  Subject - 6  Newsletter - 0

DOCUMENTATION OF THE CALIFORNIA RIGID PAVEMENT
MANAGEMENT SYSTEM (RPMS) MICROCOMPUTER PROGRAM
- FHWA , 1986 50 1
  Agency - 6  Subject - 19  Newsletter - 0

DRAINAGE OF HIGHWAY PAVEMENTS
- TYE ENG INC VA, 1984 136 2
  Agency - 6  Subject - 13  Newsletter - 6

DURABLE PAVEMENT MARKING MATERIALS
WORKSHOPS
- DINGLE ASS. INC DC, 1981 19 1
  Agency - 6  Subject - 16  Newsletter - 0

DUST CONTROL ON UNPAVED ROADS
- PURDUE UNIV , 1959 18+ 1
  Agency - 8  Subject - 15  Newsletter - 0

ECONOMICS OF REDUCING THE COUNTY ROAD SYSTEM: THREE CASE STUDIES IN IOWA
- USDOT , 1986 216 1
  Agency - 24  Subject - 26  Newsletter - 0

EDUCATION AND TRAINING INFORMATION
EXCHANGE
- FHWA , 1985 41 1
  Agency - 6  Subject - 24  Newsletter - 0

EFFECTS OF TRAFFIC INDUCED VIBRATIONS ON
BRIDGE DECK REPAIRS
- UNIV KANSAS , 1983 22 1
  Agency - 12  Subject - 12  Newsletter - 0

EFFECTS OF TAXI REGULATORY REVISION IN
SAN DIEGO CA
- DE LEUW CATHOR & CO CA, 1983 216+ 1
  Agency - 1  Subject - 1  Newsletter - 0
EFFECTS OF TAXI REGULATORY REVISION IN SEATTLE WASH
- DE LEUW CATHER & CO CA, 1983 160+ 1
  Agency - 1 Subject - 1 Newsletter - 0

ENGINEERED WOOD TRUSSES
- SE TRUSS MAN. ASS. , 1983 28 1
  Agency - 13 Subject - 12 Newsletter - 0

ENGINEERING BULLETIN OF PURDUE UNIV.
- PURDUE UNIV. , 1987 111 2
  Agency - 8 Subject - 27 Newsletter - 0

ENGINEER’S POTHOLE REPAIR GUIDE
- COLD REGIONS TECH DIGEST, 1984 12 BOX
  Agency - 21 Subject - 19 Newsletter - 11

ENVIRONMENTAL IMPACTS OF BART
- METRO TRANS COMM , 1979 20 1
  Agency - 29 Subject - 24 Newsletter - 0

EPOXY THERMOPLASTIC (ETP) PAVEMENT MARKING MATERIAL
- FHWA , 1983 2 6
  Agency - 6 Subject - 6 Newsletter - 0

EPOXY THERMOPLASTIC TRAFFIC MARKING MATERIAL
- FHWA , 1982 53 1
  Agency - 6 Subject - 6 Newsletter - 0

ESTIMATING PATRONAGE FOR COMMUNITY TRANSIT SERVICES
- USDOT , 1984 99 1
  Agency - 24 Subject - 1 Newsletter - 0

EUROPEAN PARATRANSIT EXPERIENCE
- ECOPLAN INTER. FRANCE, 1981 42+ 1
  Agency - 24 Subject - 2 Newsletter - 0

EVALUATION OF INTERGOVERNMENTAL RESPONSIBILITIES FOR MAINTENANCE
- FHWA , 1979 126 1
  Agency - 6 Subject - 19 Newsletter - 0
EVALUATION OF SNOWPLOWABLE MARKERS
- UNIV KENTUCKY , 1982 35 3
  Agency - 6  Subject - 16  Newsletter - 0

EVALUATION OF STREETER AMET
13 CHANNEL VEHICLE TYPE PROGRAM
- KANSAS DOT, 1985 11 1
  Agency - 9  Subject - 12  Newsletter - 0

EVALUATION WORKBOOK FOR PUBLIC SAFETY MANAGERS
- VIRGINIA COMM UNIV , 1982 26 1
  Agency - 24  Subject - 2  Newsletter - 0

FEDERAL REGISTER
- DOT , 1980 21 1
  Agency - 24  Subject - 17  Newsletter - 0

FHWA PUBLICATIONS INDEX
- FHWA , 1984 62 1
  Agency - 6  Subject - 24  Newsletter - 0

FHWA PUBLICATIONS INDEX
- FHWA , 1987 62 1
  Agency - 6  Subject - 24  Newsletter - 0

FIELD EVALUATION OF A GENERIC THERMOPLASTIC PAVEMENT MARKING MATERIAL
- FHWA , 1984 20 1
  Agency - 6  Subject - 16  Newsletter - 0

FIELD EVALUATION OF AN IMPACT TESTING DEVICE FOR MEASURING BASE COURSE STRENGTH
- PURDUE UNIV , 1983 78 1
  Agency - 8  Subject - 18  Newsletter - 0

FIELD INSPECTION GUIDE FOR RESTORATION OF JOINTED CONCRETE PAVEMENTS
- FHWA , 1987 54 1
  Agency - 6  Subject - 14  Newsletter - 0

FIELD MAINTENANCE MANUAL FOR GA COUNTIES LOCAL ROADS AND STREETS
- GA TECH , 1975 184+ 1
  Agency - 15  Subject - 19  Newsletter - 0
FIELD MANUAL ON DESIGN AND CONSTRUCTION OF SEAL COATS
- US DOT, 1981 84 1
  Agency - 24  Subject - 19  Newsletter - 0

FIELD TEST OF THE GRADE SEVERITY RATING SYSTEM
- FHWA, 1985 49 1
  Agency - 6  Subject - 27  Newsletter - 0

FILMS FOR HIGHWAY SAFETY AND TRAFFIC ENGINEERS
- FHWA, 1986 184 3
  Agency - 6  Subject - 24  Newsletter - 0

FINANCIAL ASSISTANCE GUIDELINES
- FEMA, 1984 150+ 1
  Agency - 14  Subject - 8  Newsletter - 0

FINANCING AND SUSTAINING MOBILITY PROGRAMS IN RURAL AREAS
- USDOT, 1986 60 1
  Agency - 24  Subject - 26  Newsletter - 0

FINANCING RURAL ROADS AND BRIDGES
- USDA, 1984 225 2
  Agency - 10  Subject - 26  Newsletter - 0

FINGERPRINTING VERSUS FIELD PERFORMANCE OF PAVING GRADE ASPHALTS
- FHWA, 1984 132 1
  Agency - 6  Subject - 6  Newsletter - 0

FLEXIBILITY DOCUMENT
- USDOT, 1986 80 1
  Agency - 24  Subject - 35  Newsletter - 0

FLEXIBLE DELINEATOR POST TEST PROCEDURES FHWA-TS-84-225
- FHWA, 1984 85 1
  Agency - 6  Subject - 2  Newsletter - 10

FLEXIBLE PAVEMENT MANAGEMENT SYSTEM MICROCOMPUTER PROGRAM BASED ON CALIFORNIA PMS
- CALTRANS, 1981 15+ 1
  Agency - 6  Subject - 8  Newsletter - 0
FLEXIBLE PARKING REQUIREMENTS
- PUBLIC TECH INC. D.C., 1982 15+ 1
  Agency - 24  Subject - 20  Newsletter - 0

FLY ASH FACTS FOR HIGHWAY ENGINEERS
- FHWA, 1986 47 1
  Agency - 6  Subject - 35  Newsletter - 0

FORT DUQUESNE BRIDGE: FRACTURE ANALYSIS OF FLANGE CORES
- FHWA, 1984 60 1
  Agency - 12  Subject - 6  Newsletter - 9

FOURTH INTERNATIONAL CONFERENCE ON LOW-VOLUME ROADS VOLUME 1
- TRB, 1987 317 2
  Agency - 18  Subject - 27  Newsletter - 0

FOURTH INTERNATIONAL CONFERENCE ON LOW-VOLUME ROADS VOLUME 2
- TRB, 1987 340 2
  Agency - 18  Subject - 27  Newsletter - 0

FRONT END LOADERS 2-3 CYD ARTICULATING RUBBER TIRED 4-WHEEL DRIVE
- PURDUE UNIV, 1983 8 1
  Agency - 8  Subject - 11  Newsletter - 0

FUNDAMENTALS OF THE STABILIZATION OF SOIL WITH LIME
- NATIONAL LIME ASSOCIATION, 1987 20 1
  Agency - 30  Subject - 18  Newsletter - 0

GASAHOL FACTS ABOUT
- SOLAR ENERGY INF DATA BANK, 1977 5 1
  Agency - 24  Subject - 21  Newsletter - 0

GEORGIA TRUCK WEIGHT LAWS AND TRAFFIC CONTROL WORKSHOP
- GDOT, 1984 15+ 1
  Agency - 15  Subject - 28  Newsletter - 12

GOOD PRACTICES GUIDE FEDERAL-AID URBAN SYSTEM PROGRAM
- FHWA, 1985 22 1
  Agency - 6  Subject - 26  Newsletter - 0
GREEN BAY TRANSIT SERVICE COST ALLOCATION STUDY
- USDOT, 1986 45 1
  Agency - 24 Subject - 1 Newsletter - 0

GROWTH MANAGEMENT AND TRANSPORTATION
- PUBLIC TECH INC. D.C., 1982 29+ 1
  Agency - 24 Subject - 8 Newsletter - 0

GUIDELINES FOR DESIGN OF LOCAL ROADS AND STREETS
- PENNDOT, 1983 65+ 1
  Agency - 16 Subject - 22 Newsletter - 0

GUIDELINES FOR MAKING PEDESTRIAN CROSSING STRUCTURES ACCESSIBLE
- FHWA, 1984 27 1
  Agency - 6 Subject - 23 Newsletter - 0

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- UNIV OF CALIF , 1983 20 1
  Agency - 13  Subject - 10  Newsletter - 0

TRAFFIC SIGNAL TIMING -- BEFORE AND AFTER STUDIES: A BIBLIOGRAPHY
- UNIV CALIF , 1983 6 2
  Agency - 13  Subject - 10  Newsletter - 0
TRAFFIC SIGN HANDBOOK
- NYDOT, 1985 103 1
  Agency - 30  Subject - 10  Newsletter - 0

TRAFFIC STRIPE REMOVAL
- FHWA, 1980 60 1
  Agency - 6  Subject - 16  Newsletter - 0

TRANSIT CAPITAL PLANNING IN THE SAN FRANCISCO BAY AREA
- USDOT, 1983 35+ 1
  Agency - 24  Subject - 26  Newsletter - 0

TRANSIT DATA COLLECTION DESIGN MANUAL
- USDOT, 1985 273 2
  Agency - 24  Subject - 1  Newsletter - 0

TRANSIT INVENTORY SYSTEM CASE STUDY
- USDOT, 1985 58+ 1
  Agency - 24  Subject - 1  Newsletter - 0

TRANSIT MANAGEMENT WORKSHOP
- UNIV WIS, 1982 5 1
  Agency - 1  Subject - 1  Newsletter - 0

TRANSIT SUBSIDY ALLOCATION TECHNIQUES
- THE OMEGA GROUP INC. WASH DC, 1983 21+ 1
  Agency - 24  Subject - 1  Newsletter - 0

TRANSIT WORKS: 10 RURAL CASE STUDIES
- IND DOT, 1982 100 1
  Agency - 24  Subject - 1  Newsletter - 0

TRANSPORTATION ENERGY CONTINGENCY PLANNING:
QUANTIFYING THE NEEDS FOR TRANSIT ACTIONS
- NY DOT, 1983 111 1
  Agency - 24  Subject - 21  Newsletter - 0

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TRANSIT FUEL SUPPLIES UNDER DECONTROL
- CABOT CONS GROUP WASH DC, 1982 38 1
  Agency - 24  Subject - 21  Newsletter - 0
TRANSPORTATION ENERGY MANAGEMENT:
CURRENT TRANSIT OPERATOR ACTIVITIES
- METRO SEATTLE, 1982 24+ 1
  Agency - 24  Subject - 21  Newsletter - 0

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TRANSIT OPERATOR FACILITIES VOL. 1 OFFICE GUIDE
- METRO SEATTLE, 1982 36 1
  Agency - 24  Subject - 21  Newsletter - 0

TRANSPORTATION ENERGY MANAGEMENT:
TRANSIT OPERATOR FACILITIES VOL. 2 FIELD GUIDE
- METRO SEATTLE, 1982 105 1
  Agency - 24  Subject - 21  Newsletter - 0

TRANSPORTATION IN GEORGIA
- GDOT, 1983 24 1
  Agency - 15  Subject - 27  Newsletter - 0

TRANSPORTATION INSTITUTIONAL BOTTLENECKS AND BARRIERS TO U.S. EXPORTS
- USDOT, 1984 157 1
  Agency - 24  Subject - 35  Newsletter - 0

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- PUBLIC TECH WASH DC, 1980 50 1
  Agency - 17  Subject - 3  Newsletter - 0

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SUMMARY
- PUBLIC TECH INC., 1982 283 1
  Agency - 24  Subject - 4  Newsletter - 0

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- TRB, 1986 59 1
  Agency - 18  Subject - 24  Newsletter - 0

TRANSPORTATION SYSTEMS MANAGEMENT
IMPLEMENTATION AND IMPACTS
- CASE STUDIES US DOT, 1982 300+ 1
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- FINAL REPORT US DOT, 1982 115 1
  Agency - 24  Subject - 1  Newsletter - 0
TRANSPORTATION WORKPLACE SURVEY
- NAT ANALYSTS, 1981 300+ 1
  Agency - 15  Subject - 4  Newsletter - 0

TRENDS BEFORE THE SAN DIEGO TROLLEY
- SAN DIEGO, 1982 176 1
  Agency - 1  Subject - 1  Newsletter - 0

TRUSS RATING AND ANALYSIS PROGRAM
- FHWA, 1986 56+ 2
  Agency - 6  Subject - 12  Newsletter - 0

UPGRADING DEFICIENT THROUGH TRUSS BRIDGES
- SHELADIA ASS. MD, 1993 122 2
  Agency - 6  Subject - 12  Newsletter - 4

USE OF UTPS FOR SUBAREA HIGHWAY ANALYSIS: A CASE STUDY
- USDOT, 1985 56 1
  Agency - 24  Subject - 32  Newsletter - 0

USER-SIDE SUBSIDIES FOR THE ELDERLY AND HANDICAPPED IN LAWRENCE MA
- UMTA, 1984 118 1
  Agency - 1  Subject - 23  Newsletter - 0

USER-SIDE SUBSIDY PROGRAMS FOR SPECIAL NEEDS TRANSPORTATION
- UMTA, 1983 97+ 2
  Agency - 1  Subject - 1  Newsletter - 0

UTCS FUNCTIONAL HARDWARE SPECIFICATIONS HANDBOOK
- FHWA, 1986 100+ 2
  Agency - 6  Subject - 32  Newsletter - 0

UTILITY POLE ACCIDENT COUNTERMEASURES EVALUATION PROGRAM AND INPUT PROCESSOR USERS MANUAL
- FHWA, 1986 76 1
  Agency - 6  Subject - 2  Newsletter - 0

VALUE ENGINEERING CONTRACT PROVISIONS ON FEDERAL-AID HIGHWAY CONSTRUCTION PROJECTS
- FHWA, 1984 27 1
  Agency - 6  Subject - 26  Newsletter - 0
VALUE ENGINEERING STUDY OF DRAINAGE MAINTENANCE
- FHWA, 1982 19+ 1
  Agency - 6  Subject - 13  Newsletter - 0

VALUE ENGINEERING STUDY OF GUARDRAIL AND IMPACT ATTENUATOR REPAIR
- FHWA, 1987 51 2
  Agency - 6  Subject - 17  Newsletter - 0

VEHICLE MAINTENANCE PRACTICES AMONG GRANTEES
- WASH DOT, 1981 27+ 1
  Agency - 24  Subject - 1  Newsletter - 0

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- USDOT, 1986 67 2
  Agency - 24  Subject - 26  Newsletter - 0

WAGE SURVEY OF ROAD AND STREET EMPLOYEES IN INDIANA COUNTIES AND CITIES-1984
- PURDUE UNIV, 1984 34+ 1
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WARRANTS FOR TEMPORARY POSITIVE BARRIERS IN HIGHWAY WORK AREAS
- USDOT, 1982 13 1
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WHAT HAPPENS WHEN YOUR PROPERTY IS NEEDED FOR A FEDERAL-AID HIGHWAY
- GA DOT, 1980 20 1
  Agency - 15  Subject - 28  Newsletter - 0

WHO'S GOING TO CALL THE FIRST MEETING ACTION GUIDE FOR LOCAL DRUNK DRIVING PROGRAMS
- NHTSA, 1983 50+ 1
  Agency - 2  Subject - 34  Newsletter - 0

WILDLIFE CONSIDERATIONS IN PLANNING AND MANAGING HIGHWAY CORRIDORS
- US DEPT OF INTERIOR, 1982 93 1
  Agency - 6  Subject - 27  Newsletter - 0

WORLD'S FAIR TRANSPORTATION SYSTEM EVALUATION 1982
- TENN DOT, 1982 174 1
  Agency - 1  Subject - 1  Newsletter - 0
YOUR RIGHTS AND BENEFITS
AS A HIGHWAY DISPLACEE
OFF. OF ROW, 1981 46 1
Agency - 6  Subject - 28  Newsletter - 0
APPENDIX C—Video Tape List
The Technology Transfer Center is beginning a video tape library. The VHS tapes listed below may be borrowed, at no charge, for a two week period. Please phone or write and request no more than two tapes at a time. Specify the tapes you want by the number in the left hand column.

SAFETY AND TRAFFIC

ST-201  The Winners--The Losers (13 minutes)
Safe use of lift trucks including inspection and hazards facing operators.

ST-205  Traffic Control and Tort Liability (50 minutes)
Gives suggestions concerning traffic control devices for local jurisdictions to help avoid tort liability suits.
Tort Liability (60 minutes)
Discusses tort liability and local jurisdiction responsibility with respect to design and operation of transportation facilities.

ST-212  Night Safety at Worksites (12 minutes)
Specifications for providing a safe nighttime environment in construction zones.
Work Area Flagging (25 minutes)
When and where to use flagging, responsibilities and requirements of flaggers, and proper flagging procedures.
Selection and Use of Traffic Control Devices (30 minutes)
Objectives of work area traffic control, selection of proper control devices.

ST-213  Introduction to Work Area Traffic Control (30 minutes)
Basic principles of work area traffic control and inputs into selecting proper traffic control.
Partners in Safety (15 minutes)
Describes work area traffic control and how to use it properly to achieve cooperation between the road user, contractor and flagger.
Sample Applications of Work Area Traffic Control (30 minutes)
Devices used as work area traffic control for both mobile or short and long term construction zones.
Speed Zoning by Montana Highway Patrol (30 minutes)
Describes background and misconceptions of speed zoning and the procedures for determining speeds of highways and local roads.

MAINTENANCE

M-201  The Snowfighters (24 minutes)
Methods, procedures, and equipment for snow removal on streets and highways.
M-202  Down is Up (20 minutes)
Preventive maintenance is stressed to reduce down time on construction sites.

M-203  The Choice is Yours (18 minutes)
Preventive maintenance on diesel engines is stressed to get maximum life from the engine.

M-204  Signals: Read 'Em or Weep (20 minutes)
Indications of problems with equipment.

M-205  Upgrading Gravel Roads (20 minutes)
Discusses how gravel and asphalt roads can be recycled using low cost alternatives.
Rural Roads, A New Approach (27 minutes)
Discusses gravel road problems and solutions to these problems including the use of filter fabrics on gravel roads and strengthening old bridges to handle modern loads.

M-206  Introduction to Bridge Inspection (25 minutes)
Prepared for agencies that are required to inspect bridges in their jurisdiction. Covers federal requirements, reference materials, condition inspection and rating, structural inventory, and safety considerations.
Pre-Stressed Concrete Bridge Inspection (50 minutes)
Describes pre-stressed concrete bridges, inspection sequence, and how to prepare for an on-site inspection.
Inspection of Pin and Link Details on Bridge Structures (32 minutes)
Discusses pin and link details and inspection procedures.

M-207  Steel Truss Bridge Inspection (50 minutes)
Discusses inspection of small truss bridges including equipment, reporting forms, and what to look for.
Timber Bridge Inspection (50 minutes)
Describes common problems with timber bridges and demonstrates how the inspection is conducted.

M-208  Roadway Maintenance Cost Analysis--Part I (50 minutes)
Discusses equipment costs including depreciation, fuel, oil, grease, maintenance, repair, and capital investment.
Roadway Maintenance Cost Analysis--Part II (50 minutes)
Discusses maintenance operating costs relating to labor, equipment, materials, and overhead.

M-209  Roadway Maintenance Cost Analysis--Part III (50 minutes)
Discusses the cost of deferred maintenance.
Roadway Maintenance Cost Analysis--Part IV (50 minutes)
Gives ideas on how to present budget data to county commissioners and city councils.
M-210  Maintenance of Highway Safety Hardware (45 minutes)
How to provide safe roadside environments through periodic maintenance of the road side and its safety hardware.

M-211  Maintaining Granular Surfaced Roads (18 minutes)
Instructional guide to enable road grader operators to provide better maintenance of granular surfaced roads.

Snow Removal on Iowa's Secondary Roads (20 minutes)
Instructional guide for snowplow operators for winter road maintenance of secondary roads.

M-212  Ditchmaster (10 minutes)
Demonstration of the ditchmaster, a cost effective machine for improving roadside drainage and maintenance.

Lee-Boy Asphalt Maintainer (15 minutes)
Demonstration of the Lee-Boy, an asphalt and maintenance machine.

Rosco Asphalite Maintainer (15 minutes)
Demonstration of a pot hole repair machine.

M-213  Techniques for Pavement Maintenance and Rehabilitation Using Asphalt--Part I
Introduction (15 minutes)
Introduction to a series of tapes dealing with using asphalt for pavement maintenance and rehabilitation.

Asphalt Components, Materials, Tests, and Basics of Design (40 minutes)
Discusses the components of an asphalt paving structure from subgrade to the asphalt top.

M-214  Techniques for Pavement Maintenance and Rehabilitation Using Asphalt--Part II
Pavement Deterioration Ratings (30 minutes)
Discusses graphs involving pavement deterioration, cost of rehabilitation, pavement life and rating of pavement deterioration.

Types of Patching and Crack Sealing (52 minutes)
Examples of pavement deterioration and discusses methods of patching, crack sealing and equipment used.

M-215  Techniques for Pavement Maintenance and Rehabilitation Using Asphalt--Part III
Sealing of Joints in Portland Cement Concrete (25 minutes)
Discusses cleaning and sealing of joints in Portland cement concrete roadways.

Surface Treatment of Pavement (54 minutes)
Discusses objectives and methods of applying seal coats, spraying of liquid asphalt, surface condition variables, spraying oil onto pavement and spreading aggregate.

M-216  Techniques for Pavement Maintenance and Rehabilitation Using Asphalt--Part IV
Cost Analysis (20 minutes)
Discusses methods and strategies for determining which method of maintenance is needed. Cost analysis is emphasized.
Recycling Procedures (35 minutes)
Describes recycling procedures with asphalt and shows some of the equipment used.

**DESIGN AND CONSTRUCTION**

**DC-201**  
800 Miles of Winter (28 minutes)  
Construction of the Trans-Alaskan pipeline.  

Men Against Rock (30 minutes)  
Discussion of construction in rocky areas on a variety of projects including drilling, blasting, earth moving and tunneling.  

Why Handle It Twice? (16 minutes)  
Construction and reclamation of an open-pit coal mine using scrapers.  

The New Shape of Value (14 minutes)  
Demonstrates the capabilities of the Caterpillar D-10 unit including ripping, push loading of scrapers and dozing.  

Versatility with a Boom (10 minutes)  
Shows multiple uses of hydraulic excavators.

**DC-202**  
The Roll of Drums (18 minutes)  
Discusses taking unnecessary chances on construction work sites.  

Shake Hands with Danger (23 minutes)  
Safety procedures for operating and maintaining earth moving machines.  

Making the Most with Scrapers (23 minutes)  
The productive use of scrapers.  

Operating Tips: Elevating Scrapers (11 minutes)  
Discusses inspection, start-up procedures and work alone features such as cutting and loading material.  

Operating Tips: Wheel-Tractor Scrapers (18 minutes)  
Discusses inspection, start-up procedure, and operating techniques.

**DC-203**  
Operating Tips: Push-Pull Scrapers (12 minutes)  
Discusses cut and fill operations for pairs of scrapers.  

Operating Tips: Off-Highway Trucks (17 minutes)  
Discusses inspection, start-up procedure and off-road operations.  

Operating Tips: Track-Type Tractors (15 minutes)  
Considerations for safe and efficient operation including inspection, dozing, land clearing, ripping and push loading scrapers.  

Loading Logic (17 minutes)  
Efficient choice and use of loaders and trucks for hauling soil.  

Operating Tips: Wheel-Tractor Scrapers (18 minutes)  
Discusses inspection, start-up procedure and operating techniques.  

Operating Tips: Track-Type Loaders (10 minutes)  
Discusses inspection, start-up procedure and excavation for a variety of cases.  

Operating Tips: Wheel Loaders (10 minutes)  
Discusses inspection, start-up procedure and operation.

**DC-204**  
Tied Concrete Shoulder (10 minutes)  
Shows construction of tied concrete shoulders, undersealing of
existing pavement and full-depth repair of the pavement.

Recycling D-Cracked Concrete Pavement (12 minutes)
Discusses the reasons for the use of concrete recycling over conventional methods of construction.

Bonded Concrete Overlay (12 minutes)
Shows a bonded concrete overlay on existing concrete pavement.

Interstate Reconstruction--Part I (12 minutes)
Recycling existing D-Cracked pavement as aggregate for new concrete pavement.

Whitetopping (7 minutes)
Discusses placing a concrete overlay on distressed asphalt concrete.

Design for Quality (12 minutes)
Shows recycling of concrete pavement and replacement with continuously reinforced concrete pavement, bonded concrete overlay and tied concrete shoulders.

Interstate Reconstruction--Part II (13 minutes)
Shows add-on tied concrete shoulders, diamond grinding for smoothness, and establishing new transverse joints.

Recycling Continuously Reinforced Concrete Pavement (10 minutes)
Shows the recycling of existing continuously reinforced concrete pavement as aggregate for new concrete pavement.

Unbonded Concrete Overlay (12 minutes)
Construction of a full-depth unbonded overlay over a reinforced concrete pavement.

Testing of Asphalt Cement (24 minutes)
Procedures for various tests of asphalt cement including flashpoint, penetration, ductility solubility, spot softening point, specific gravity and thin film over tests.

Determination of Asphalt Content in Paving Mixtures (20 minutes)
Procedures for determining asphalt content for proper life and serviceability of asphalt cement.

Budgeting for Rehabilitation (25 minutes)
Presents economic situation of restoring paved highways and evaluation of pavements for determination of priority for restoration.

Asphalt Emulsion Spray Applications (20 minutes)
Reasons for using asphalt emulsions, what constitutes asphalt emulsions, how they work, and processes for applying asphalt emulsions.

Aggregate Blends (40 minutes)
Demonstrates graphical procedure for blending aggregate sources to meet proper specifications.

AASHO Road Test
Construction and Materials (27 minutes)
Discusses materials and construction of extensive test facilities constructed in 1956 by AASHO to test different types of road surfacings, bases, bridges and methods of construction.
the AASHO Road Test.
The Road to Better Roads (14 minutes)
Summarizes the purposes and procedures of the AASHO Road Test and discusses what is being done today to improve roads.

DC-209 Verglimit--Mixing and Laying (10 minutes)
Proper procedures for handling, storing, mixing and laying verglimit asphalt cement, ice and snow retarders.

DC-210 I-90 The Final Link (20 minutes)
The completion of I-90 near Seattle; its design and construction problems.
Basics of the Local Road Engineer (50 minutes)
The basic components of road engineering are covered, emphasis on traffic safety.

DC-211 Energy Conservation in Community Water Systems (25 minutes)
Conservation methods used in water systems to help reduce operating expenses and operating budgets.
The Importance of Road Drainage (40 minutes)
Describes how to make an inventory of drainage structures for easier maintenance by mapping these structure and problem flood areas; fundamentals of design and sizing of culverts and ditches.

DC-212 Stabilization for Low-Volume Roads (10 minutes)
Describes adding soil stabilizing agents to low volume roads to increase drainage capabilities, base stabilization and reduce maintenance costs.
Oklahoma Slide Show on Geotextiles (25 minutes)
Experiments using geotextiles cloth overlayed with gravel in roadways during wet conditions.
Stabilization, Holding the Road (20 minutes)
Demonstrates the process of building a stabilized road and shows the advantages of stabilized roads over surface treated roads.
Lime: The Versatile Soil Stabilizer (25 minutes)
Use of lime in road stabilization, its history, advantages, uses, process for making lime, and how to use lime in the construction process.

DC-213 Standard Soil Tests (40 minutes)
Describes several standard AASHTO soils tests.
Concrete Field Testing and Sampling (25 minutes)
Complete process for the concrete field tester. Shows tests for slump, air content, unit weight, chase indicator, kellyball and preparation of concrete cylinders for strength tests.
AASHTO T-99 (12 minutes)
Determines the moisture-density relationship of soils.
AASHTO-27 (20 minutes)
Sieve analysis for both fine and coarse aggregates.

DC-214 Design of Urban Streets--Part I
Conceptual Approach to Urban Street Design (25 minutes)
Introduction to series of tapes on urban street design.
Capacity (30 minutes)
Describes concepts of road capacity and level of service, peak hour factor, load factor as references from the highway manual.

Techniques for Maximizing Capacity to Traffic Studies (30 minutes)
Describes techniques for maximizing capacity on roads and at intersections.

Street Design Elements--Part I (30 minutes)
Discusses location design of urban streets and coordination of facilities. Also includes discussion of metric units in design.

DC-215 Design of Urban Streets--Part II
Street Design Elements - Part 2 (30 minutes)
Describes cross-sectional design and horizontal alignment design.

Street Design Elements - Part 3 (30 minutes)
Describes vertical alignment design, design of vertical curves, drainage design and design for access control.

Intersection Design Elements (30 minutes)
Describes the basic intersection types, types of channelization, corner design pedestrian movement, vehicular movement and turning movements.

Intersection Design Elements (Continued) (30 minutes)
Describes intersection control, problem identification and improvement techniques for problem areas. It also describes some type of urban and freeway techniques.

DC-216 Design of Urban Streets - Part III
Traffic Signal Design and Operation (30 minutes)
Basic principles of signals, advantages, disadvantages, the various types of signals and operations of different traffic signals.

Illumination, Signs and Markings (30 minutes)
Advantages of lighting arterial streets, types of lights and elements considered in designing lighting systems, importance of signs and markings in street design and uniformity of signs and markings.

Pedestrians, Bicycles and Transit Considerations (30 minutes)
Discusses the integration and design of pedestrian, bicycle and transit facilities into the urban street plan.

Factors Impacting Street Design (30 minutes)
Special factors which affect the design of urban streets.

DC-217 Design of Urban Streets - Part IV
Social and Economic Impacts (30 minutes)
Social and economic impacts by the upgrading or design of new urban roadway facilities.

Environmental Consideration (30 minutes)
Environmental impact caused by urban street design. Emphasis on air and noise pollution.

Project Documentation (30 minutes)
Evaluation techniques for comparing design alternatives and selections.

Administration and Management (30 minutes)
Consultant selections, bid procedures, contractor prequalifications, supervision of work and legal aspects of the design and designer.
DC-218 Asphalt Paving Inspection (28 minutes)
Discusses sampling of aggregate, storage, cold feed, mixing plant and plant inspection.
Pothole Repair (12 minutes)
Demonstrates traffic control during repair, marking, cleaning, filling and cleanup.
COMPLETE AND RETURN TO:

John Moskaluk
Technology Transfer Center
Department of Civil Engineering
Georgia Institute of Technology
Atlanta, Georgia 30332

NAME: ________________________________

POSITION: ________________________________

AGENCY: ________________________________

ADDRESS: ________________________________

CITY: __________ STATE: _____ ZIP: ______ PHONE: ______

VIDEO TAPES YOU WISH TO ORDER: (1) _______ (2) _______

ALTERNATE CHOICES: (1) _______ (2) _______
APPENDIX D--Newsletters
FRONT-END LOADER SAFETY

The front-end loader is one of the most hazardous pieces of equipment that we use in road work.

Fatalities involving the front-end loader lead all other equipment used in the mineral industry. Statistics show that most accidents occur while the machine is backing up. Most fatalities occur when the unloaded machine is being driven at high speeds from one area to another. This is especially dangerous because the front-end loader, when empty, tends to bounce and weave at high speeds. Downgrades are also particularly hazardous due to the increased problems in controlling the vehicle.

Other hazards include collisions with other equipment while operating in congested areas, getting caught in pinch points of the bucket arms or articulated steering, and spilling of parts of the load on the operator or others working in the area.

1. Before starting the front-end loader, the operator should check the machine for safety factors, including tires, brakes, emergency brakes, hydraulic systems, steering, lights, and alarm systems. Use a checklist. If anything is wrong with the equipment, it should be reported. Do not start the machine if it is not in safe condition!

2. The operator should wear the proper protection equipment for the job: safety hat, shoes, and glasses, and any other equipment needed for the specific job.

3. Before starting the machine, the operator should make a thorough check of the area around the machine to be sure that the area is clear for movement.

4. No riders other than the operator should ever be allowed on the machine.

5. The operator should move the equipment very cautiously, especially in congested areas. When backing, the operator must have a clear field of vision and signal by horn or other device so that others in the area will know what he is doing.

6. While driving the machine, the operator should consider road conditions, weather, traffic, and grade. The loader should be moved at a speed slow enough to ensure total operator control at all times.

7. When working near embankments or on grades, edges must be guarded by riprap, barricades, berms, or other suitable means to lessen the possibility of running off the edge. The loader speed should be regulated to a minimum, the engine should be engaged, and the transmission should be in low range.

8. In loading a truck, load from the driver’s side whenever possible. The loader must know where the driver is at all times and traffic patterns for the area must be known and followed.

9. On leaving the cab, the bucket must be grounded and the machine shut down and locked to prevent any use by unauthorized persons.

EDITOR'S NOTE

GOOD NEWS! The Department of Transportation has agreed to renew our contract, so we will be here for you for another year. We are looking forward to our sixth year Georgia. Please remember to call us for publications, traffic counters, video tapes, or technical assistance. (Also, you need to be on our mailing list to stay updated on upcoming workshops.)

During the next year, we will be increasing our registration fee for workshops to $50.00. This minimal fee does not begin to cover our costs. It is simply a means for the local agencies to express their support of and interest in the programs of the Technology Transfer Center. We certainly hope that this fee will not deter anyone from attending.

"Roadway Tort Liability in Georgia", a workshop which the Technology Transfer Center co-sponsored with the Georgia Division of the Institute of Transportation Engineers was held on October 28 and was a great success. Almost 110 people attended, reiterating our belief that the issue of tort liability is a hot one for today's transportation officials. We also held six sessions of "Traffic Applications of Microcomputers". Thank you to everyone who participated in these workshops.

An estimated 21,015 traffic fatalities occurred on the nation's highways during the first six months of 1986. Drivers accounted for 58 percent of the total fatalities, passengers for 25 percent, and non-occupants (pedestrians and pedalcyclists) for the remaining 17 percent.

About 56 percent of the fatalities occurred in rural areas. More than 71 percent of all fatalities were males, and 60 percent of the total were under 35 years of age. Fatalities were most frequent for the 20- to 24-age group, followed by the 15- to 19- and the 25- to 34-age groups.

While traffic fatalities in 1986 occurred at different rates depending on the time of day and day of week, the peak occurred between midnight Friday and 3:00 a.m. Saturday.

More than half of all traffic fatalities involved alcohol consumption. While the prevalent legal limit for intoxication is 0.10 of blood alcohol concentration, 41 percent had exceeded this limit.

The United States has 3.9 million miles of roadway, of which 3.2 million miles are rural roads which carry 80% of the total travel.

A preliminary study conducted by the National Highway Traffic Safety Administration found that the rear high-mounted stop lamp now required on new passenger cars has been effective in preventing rear-end collisions. The study, based on police reported collisions that occurred between June 1 and September 5, 1986 in 50 counties which make up the statistically representative National Accident Sampling System, indicated that vehicles equipped with the center high-mounted stop lamp were 22 percent less likely to be struck in the rear by another vehicle while braking. It is indicated that the lamps reduce the reaction time needed for drivers to apply their brakes when the vehicle in front of them is braking and are especially effective in preventing chain collisions.

Transportation engineers at the University of Kentucky are using sophisticated electronics to "hear" the sound of bridges cracking. With a new computer-based technology called acoustic emission monitoring, researchers can pinpoint growing fractures or cracks in steel beams by detecting the energy they release as traffic passes over the bridge. Transducers, amplifiers, and a portable microcomputer are used to detect sonic emissions from growing cracks—"sounds" which have frequencies up
to one megahertz and are inaudible to the human ear. After testing several major bridges in Kentucky and other states, Theodore Hopwood, director of the Kentucky research team, reports that acoustic emission testing is reliable for detecting flaws in steel bridges and is fast and convenient. Bridges can be inspected without drilling or being closed to traffic, and the technology is more efficient than many conventional methods, including ultrasound. For further information, contact Theodore Hopwood at (606) 257-4517.

In Finland, England, and Sweden, convicted drunk drivers are automatically jailed for approximately one year. The names of drunk drivers are published in local newspapers. South Africans are given ten-year prison sentences, a fine of $10,000, or both. In Turkey, drunk drivers are taken 20 miles from town and forced to walk back under escort. A second conviction of drunk driving in Bulgaria is punished by execution.

Effective July 1, 1987, Federal regulations make it illegal for certain truck and bus drivers in the U.S.A. to have more than one commercial driver’s license. This regulation applies to all operators of large trucks weighing more than 26,000 pounds, to drivers of vehicles designed to carry at least 15 passengers, and to drivers of vehicles that transport placarded hazardous materials.

The new requirement was contained in the Commercial Motor Vehicle Safety Act of 1986, and will be administrated by the Federal Highway Administration. Enforcement will also be by FHWA until such time that individual states adopt their own enforcement statutes or regulations. Stiff penalties are specified by the regulations.

Hopefully, drivers who have obtained multiple operating licenses to hide their bad driving records can be removed from our highways and the safety of the motoring public can be enhanced.

YOUR BEST DEFENSE IN THE WAR AGAINST POTHOLES

The minimum 4" pavement thickness design

Through collaboration and observations shared with other pavement engineers, an interesting and significant performance observation came up. Once a pavement is 3-1/2" to 4" in thickness, it cannot pothole (in the strict classical sense of the bowl-shaped pothole that loses pavement and is deepened and enlarged by traffic as the granular base is eroded).

In accordance with the information and test results reported by Martin Ekse, Volume 29, AAPT, 1960; W. Phang, Volume 50, AAPT, 1981; and WASHO Test Road Report, Part 2, Test Data, Analyses, and Findings; nine aspects of the 4" pavement design exist:

1. 4" minimum pavement has more strength than AASHTO or other criteria indicated by straight-line coefficient usage.

2. Distress cracking in a pavement expands and multiplies rapidly when pavements are thinner. The cracking breaks the pavement into many small pieces. However, there is less fragmentation with 4" plus pavements. Also, rutting and waviness which reflect base material stress and freeze/thaw effects are virtually eliminated on 4" plus pavements.

3. There is often a great deal of strain with a 2-1/2" design due to construction traffic in side- or subdivisions. In these situations, it is common for the design to have a 1-1/2" thickness carrying all of the construction traffic for several years. This initial layer gets easily overstressed and even cracked on the underside before it is topped with only an additional 1" wearing surface. On the other hand, with a 4" design, a 2-1/2" layer carries construction traffic adequately. A final 1-1/2" layer provides a wearing and exceptionally strong strengthening course, providing much more strength and longevity to the pavement.

4. With a 4" design pavement strength adjacent to utility cuts and castings is more substantial.

5. Added strength acquired through the use of the minimum 4" design, provides a safety factor for traffic growth and occasional overload situations. This is particularly helpful when an owner may not have control of the traffic volume or the funds available to strengthen the pavement.

Continued on page 5
MAINTENANCE TIPS

LITTER REMOVAL

Litter along the shoulders and right-of-way is a major maintenance problem. The cause of litter is inconsiderate motorists. It is normally found along any stretch of roadway but is more common along roads with very high or very low volumes of traffic.

Litter does not create a severe problem unless objects are large enough to do damage to mowers, create a hazard to drivers, or clog side ditches that may result in drainage problems. Litter removal is normally performed to provide a pleasing roadway to the motorist. The requirements for cleaning roadside litter are given below.

CREW REQUIRED

| Laborers | 2 |
| Truck driver | 1 |

EQUIPMENT REQUIRED

| Dump truck | 1 |

MATERIAL REQUIRED

None

DAILY PRODUCTION PER CREW

4-7 miles of roadway

REPAIR PROCEDURE

1. Place signs and other safety devices. Equip truck with flashing red light.

2. Place large items in truck.

3. Collect small items in litter bags. Place full bags along shoulder. Truckdriver empties litter bags into truck and returns empty bags to laborers.

4. Cover truck bed to contain litter.

5. Dump truck at designated site.

6. Remove signs.

MACHINE MOWING

Machine mowing is required for high grass, which is defined as roadside vegetation which reduces roadway visibility or is greater than 12 inches high.

The cause of high grass is insufficient mowing during the growing season. It may occur on any road with grass along the shoulders and right-of-way.

High grass creates an unpleasing roadway and may block visibility. If not maintained it will cause shoulders to become overgrown and may also create poor drainage, ditch erosion and pavement failures. More importantly, it can result in a serious safety hazard by restricting sight distance. The proper method of maintaining high grass is machine mowing, as outlined below.

CREW REQUIRED

| Laborers | 3 |

EQUIPMENT REQUIRED

| Mowers | 2 |
| Truck | 1 |

MATERIAL REQUIRED

None

DAILY PRODUCTION PER CREW

15-20 acres

REPAIR PROCEDURE

1. Place mowing signs.

2. Use largest mower first and follow with smaller.

3. Cut one swath beyond slope or 50 feet from roadside.

4. Mow each section with an odd number of swaths. This will help to eliminate "deadheading".

5. Mow grass to 5 inches height.

6. Remove signs.
Continued from page 3

(8) A minimum 4" design provides a pavement that will require surface maintenance only. Pavement treatments can be limited to individual crack sealing, liquid seals, and very thin overlays—thicker overlays are required only when traffic growth calls for it.

(7) The 4" minimum provides sufficient thickness for recycling by milling. When milling 1" from a 2-1/2' surface to a 1-1/2' in depth, little stock is left for construction traffic to travel on.

(8) Better overall pavement quality and density can be achieved by using more compactible layer thicknesses. This leads to less embrittlement and greater retention of flexibility with time.

(9) Although 2-1/2" designs have been shown in tests to be sufficient, it should be kept in mind that test road data always reflects better performance than actual practice.

When a 4" pavement is overloaded by traffic and cracks, the pavement is thick enough to resist disintegration into small pieces and to resist the type of flaming out at the crack that occurs on thinner pavements. This is why you will rarely see overnight potholing occur on a pavement greater than 4" thick. If distress is occurring, it will be evident for several years while remaining safe and serviceable. Only total neglect and lack of maintenance over many years will cause it to eventually break down into surface ravelling. However, this surface ravelling or delamination only affects rideability and appearance. It is tolerable from a safety and auto damage point of view.

Once weakened, pavement thicknesses less than 3 to 4 inches can break into pieces and pothole very easily. This is because the pieces are small enough to be turned out by tire traffic. On thicker pavements (about 3-1/2"+), the thick broken pieces act like big paving blocks and are virtually impossible to be rotated out of the hole by traffic. In other words, it fails but remains safe for traffic.

Thin pavements are sometimes best restricted to liquid asphalt surface treatments that require frequent maintenance treatments every few years. These asphalt surface treatments are only recommended for very low volume roads, particularly those that do not have significant truck traffic. Such thin pavements must have excellent drainage designed into them and be diligently maintained throughout their service life.

Potholes in thin pavements rapidly get deeper and larger as traffic and water work them. They are the type that most seriously affect safety and cause more damage to autos. An additional problem is the need to overcome the use of poor minimum standards in subdivision control work and new work submitted by consultants. Some of these standards still call for thin surface treatments and pavement thicknesses less than minimums recommended for permanent pavements. The lack of permanence built into these new pavements means the municipality is accepting greater annual maintenance. This problem is compounded when some consultants use the same minimum standards on the other municipal projects within the community and, worse yet, simply copy them to use in other towns as proper standards.

If standards are used, they must be reasonably conservative to cover the weaker conditions and unforeseen circumstances such as variance in soil conditions, construction quality, utility settlement and lack of maintenance when budgets are cut regardless of the pavement’s condition.

For a low maintenance permanent pavement, the thickness used by most all agencies is at least 3 inches. The Asphalt Institute has a firm policy of recommending a minimum pavement thickness of 4 inches even for low volume roads.

According to The Asphalt Institute, the minimum permanent pavement thickness when using asphalt hot mix is 4 inches. The slab strength of a 4 inch thick pavement is substantially greater than that of a 2", 2-1/2", or 3" pavement by many times: the load to produce a 1/8-inch deformation on the base is only 400 pounds on a 2 inch pavement; 3,900 pounds on a 4" pavement.


GEORGIA TECH
TECHNOLOGY TRANSFER CENTER
SCHOOL OF CIVIL ENGINEERING
ATLANTA, GEORGIA 30332
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DIRECTOR—M. JOHN MOSKALUK
EDITOR—MARTY MILLER
THE NEED FOR DEVELOPMENTAL HIGHWAYS

Georgians for Better Transportation (GBT) believes the kind of transportation system we build and maintain determines the economy we will have in the future. GBT believes the kind of transportation system we have determines the products we will sell, the industry that will locate here, the payrolls that will be met, the taxes that will be generated, the social services that will be delivered, and the quality of life we will enjoy.

GBT is, therefore, persuaded that Georgia’s four-lane developmental highway system must be expanded if the state is to retain existing business and industry, and attract new facilities that will expand the employment and tax base and enhance the quality of life of our citizens.

Many parts of Georgia have a wealth of transportation facilities, and they have paid rich dividends. But this is not the case across the state.

According to the Federal Highway Administration, only 640 miles of Georgia’s 10,196 mile primary system consists of four-lane highways. This means we rank last among the southeastern states in non-intestate, four-lane highway mileage as indicated on the following table:

<table>
<thead>
<tr>
<th>State</th>
<th>Total Primary Mileage</th>
<th>4-Lane Mileage</th>
<th>4-Lane as % of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Florida</td>
<td>8,522</td>
<td>2,631</td>
<td>30.9</td>
</tr>
<tr>
<td>Kentucky</td>
<td>3,722</td>
<td>959</td>
<td>25.8</td>
</tr>
<tr>
<td>Virginia</td>
<td>5,385</td>
<td>1,183</td>
<td>21.7</td>
</tr>
<tr>
<td>North Carolina</td>
<td>4,315</td>
<td>915</td>
<td>21.1</td>
</tr>
<tr>
<td>Alabama</td>
<td>6,623</td>
<td>777</td>
<td>11.7</td>
</tr>
<tr>
<td>Tennessee</td>
<td>5,709</td>
<td>604</td>
<td>10.6</td>
</tr>
<tr>
<td>Georgia</td>
<td>10,196</td>
<td>640</td>
<td>6.3</td>
</tr>
</tbody>
</table>

This places many areas within the state at a competitive disadvantage in their efforts to attract new business and industry. For an area’s economic development efforts to be successful, natural and human resources must be complemented by an adequate infrastructure. The key component of this infrastructure is an adequate transportation system that permits efficient shipment of raw materials and finished products, and allows the work force to travel to and from their places of employment safely, efficiently and economically.

This contention is borne out by a 1982 Fortune magazine report entitled “Why Corporate American Moves Where.” This report is the result of a survey of the 1,000 largest U.S. industrial corporations as listed in the 1981 Fortune Directories, and it reveals the following:

Three out of four respondent companies located new plant facilities in the past five years, and almost an equal number expect to do so in the five years ahead.

New distribution centers and warehouses are also high up on the shopping list for new facilities. Six out of ten companies thought the location of such facilities to be at least “fairly probable” during the next five years.

Over the last five years, the South has captured six out of ten new plant facilities reported on in this study, with “most likely” choices for the next five years showing this dominance likely to continue.

The South is a clear No. 1 as the “most likely” choice for distribution center/warehouse, laboratory, regional and corporate headquarters locations.

The majority of plan location searches start with consideration of multi-state areas.

Leading factors (in site selection) include productivity of workers, community receptivity, efficient transportation facilities, and tax considerations.

1985 MOTOR VEHICLE POPULATION (EST.)

<table>
<thead>
<tr>
<th>State</th>
<th>Pop.</th>
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<tbody>
<tr>
<td>Alabama</td>
<td>3,235,000</td>
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<tr>
<td>Florida</td>
<td>9,861,000</td>
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<tr>
<td>Georgia</td>
<td>4,606,000</td>
</tr>
<tr>
<td>Kentucky</td>
<td>2,591,000</td>
</tr>
<tr>
<td>Mississippi</td>
<td>1,443,000</td>
</tr>
<tr>
<td>N. Carolina</td>
<td>4,417,000</td>
</tr>
<tr>
<td>S. Carolina</td>
<td>2,150,000</td>
</tr>
<tr>
<td>Tennessee</td>
<td>3,612,000</td>
</tr>
<tr>
<td>Virginia</td>
<td>4,198,000</td>
</tr>
<tr>
<td>W. Virginia</td>
<td>1,451,000</td>
</tr>
</tbody>
</table>

Source: U.S. Dept. of Transportation, Federal Highway Administration, Tables SS 84-3, 1985

Since, as the Fortune study indicates, the South is expected to continue being a magnet for business and industry, and since, as the study also reveals, efficient transportation facilities are of primary importance to those who make location decisions, Georgia’s system needs to be at least as good as—if not better than—those of neighboring states.

Otherwise, a company seeking a Sun Belt location is likely to bypass a Georgia site with a favorable tax structure, positive community attitude and plentiful labor supply for a site in another state where these factors exist together with an adequate transportation system. A site, for example, to which twin trailer trucks have access. At present, these “twins” are permitted on only 550 miles of our 10,196 mile primary system. According to the Georgia Motor Trucking Association, this places Georgia lowest among the states in the percentage of primary miles designated for operation of these trucks.

Within the state, economic growth and develop-
ment in areas with efficient transportation facilities will far outstrip that in those without good highway access. Economic opportunities, therefore, are unbalanced.

This point is clearly stated in a report authored by Frank Schmalleger, Ph.D., Professor and Chairman, Department of Sociology, Pembroke State University, Pembroke, North Carolina:

Good roads stabilize society by insuring an equitable distribution of wealth. They allow industries to locate near resources and in areas with a ready work force.

Another report by Dr. David C. Colony, Professor of Civil Engineering, University of Toledo, Toledo, Ohio, lists among the consequences of an inferior road system:

- Increased cost of freight transport
- Increased agriculture costs
- Inhibited industrial development
- Reduction of property values
- Reduced local tax base
- Higher prices for goods and services
- Lower quality of life

An additional consequence of inferior roads is their impact on individual drives. A 1982 study indicated that inferior roads cost a driver an extra eighty-eight gallons of gas a year and between $45 and $800 a year in damages to the steering system, tires, suspension, brakes and shocks. On a national average, the loss is about $334 per vehicle per year. L. H. Irwin of Cornell University recently upped this figure to $355.

Beyond all this, there is the cost in human life and suffering, which no dollar price can reflect. In Georgia, the fatality rate on rural two-lane roads is 4.52 fatalities per 100 million vehicle miles (MVM), compared to 1.22 fatalities per 100 MVM on rural Interstates and 2.40 fatalities per 100 MVM on rural four-lanes, according to the Department of Transportation.

The Colony report, previously referred to, also addresses further economic impacts of increased vehicle operation costs associated with poor roads, as follows:

- Many transportation studies have demonstrated a relationship between residential location decisions of households and the work trip of the principal breadwinner. In particular, a household is free to spend on housing and trips to work no more than a certain proportion of its total income. Thus, in the event of an increase in the cost of trips to work via any highway-oriented mode of travel, a household must deal with such an increase in one of several ways:
  1. Reduce housing cost by moving to a new location, or
  2. Reduce the cost of work trips by finding new employment, or
  3. Accept a reduction in disposable income for purposes other than housing or trips to work.

Clearly, expanding Georgia's system of four-lane developmental highways would enhance the state's ability to compete with others for new business and industry, thereby reacting more job opportunities for our citizens regardless of where they live, and improving access to these jobs.

Overall benefits to a community in which a new industry located are summarized in a 1979 study commissioned by the Georgia Industrial Developers Association. This study involved a detailed survey of five medium sized (9,000 to 19,000 pop.) Georgia communities in which one large industry had provided most new private sector investment and new job opportunities since 1970. The results, which represent the average of the five communities after local

Continued on page 8

STATE GENERATED HIGHWAY FUNDS
FY 1985

<table>
<thead>
<tr>
<th>Funds</th>
<th>R</th>
<th>Mileage</th>
<th>R</th>
<th>Funds</th>
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<th>Funds</th>
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<tbody>
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<td>A</td>
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<tr>
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<td>System</td>
<td>K</td>
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<td>Mile</td>
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<tr>
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<td>40,230</td>
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<td>7</td>
<td>14,611</td>
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<tr>
<td>W. Virginia</td>
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<td>34,329</td>
<td>4</td>
<td>24,119</td>
<td>10</td>
<td>11,893</td>
</tr>
</tbody>
</table>

Source: Southern Legislative Conference, Council of State Governments, Table B
Continued from page 7

costs were deducted, indicate that the following dollar impact was realized:

- $9,500,000 additional yearly wages ($5.2 million for manufacturing plant jobs + $4.3 million for spin-off jobs).
- 641 new jobs (442 manufacturing plant jobs + 199 spin-off jobs).
- $12,150 average yearly income for new manufacturing employees.
- $3,037 25% fringe benefits per manufacturing employee (cash value).
- $301 increase in community per capita income.
- $180,327 average community property tax revenue increase.
- $331,897 highest community property tax revenue increase (in survey).
- $13 average per capita reduction in annual tax burden.
- $23 highest per capita reduction in annual tax burden (in survey).

Besides the dollar impact of these industries, other effects included the following:

- Unemployment Rate: 1.2% below state average, 2% below counties in which no manufacturing plants had located.
- Community Projects: New industries typically contributed to parks, little league teams, adult recreation, civic improvements.
- Revenues Collected by Local Government: New industry contributed 6 to 15% of the total.
- Certain Community Social Costs: Overall impact indirectly led to reduction of local welfare obligations.
- Worker Mobility: New company training programs provided greater diversification of job opportunities and upward mobility for local workers.
- Potential New Plants: Communities became more attractive for other potential plant locations because of diversified labor force.

As previously noted, GBT believes an adequate transportation system to be the key component of the infrastructure that must be in place if an area is to attract new industry and job opportunities. Thus, the organization believes that here in Georgia where, according to U.S. Department of Commerce estimates, 1981 per capita income was only 85 percent of the national average and 37th among the states, we can't afford not to provide this component so that more communities reap the kind of benefits detailed above.

The Fortune study, referred to previously, reveals that the South will continue to attract new industry. It indicates that most site selection searches start with consideration of a multi-state area. Among the leading factors that determine the ultimate choice are efficient transportation facilities, along with worker productivity, community receptivity and tax considerations. For Georgia to stand out among the other Sun Belt states, we must set the pace in each of these areas.

Yet, as noted earlier, Georgia ranks last among the southeastern states in non interstate, four-lane highway mileage. And according to data developed for the Southern Legislative Conference, Council of State Governments, we rank:

- First among the southeastern states in land area and second in population.
- But we rank:
  - Fourth in funds available for state highways;
  - Fifth in mileage on the state system;
  - Sixth in funds available for state highways per capita; and
  - Seventh in funds available per square mile of land area.

Every society is ultimately shaped by its response to the problems it confronts. GBT believes Georgia must respond to the challenge of building the four-lane developmental highway system that will provide vastly improved economic opportunities and an improved quality of life for more of our citizens.

Our state will be the richer for this investment.


ACKNOWLEDGEMENT

The Technology Transfer (T2) Program is a nationwide effort financed jointly by the Federal Highway Administration and individual State Departments of Transportation. Its purpose is to translate into understandable terms the latest state-of-the-art technologies in the areas of roads, bridges, and public transportation, to local and county highway and transportation personnel.

The T2 Center at Georgia Tech is sponsored by the Georgia Department of Transportation and provides information and counsel to more than 500 municipalities and counties in our state. This newsletter is designed to keep you informed about new publications, new techniques, and new training opportunities that may be helpful to you and your community. Individuals wishing to receive future copies of this newsletter at no cost may send their requests to:

M. John Moskaluk
Technology Transfer Center
School of Civil Engineering
Georgia Tech
Atlanta, Georgia 30332
INNOVATIONS STREAMLINE
CRACK SEALING
Accessories Save Manpower, Energy, Do a Better Job

by Bill Stark
Highway Maintenance Supervisor
Oregon Highway Division

In the past, our rubberized asphalt crack sealing operations have included a truck with driver pulling the melter, a man operating the applicator wand filling the cracks, and a third man following behind striking off the excess material with a squeegee. I have never been very satisfied with the results of using the squeegee. This is mostly because there is always waste, and the squeegee spreads the product out beyond where it is needed.

So, a few years ago we devised a different method of striking off the seal, which (1) eliminates the use of the squeegee, (2) does a better job, and (3) eliminates the need for the third man.

The key to our present method is a round disk attached to the end of our applicator wand, which takes the place of the extra man and the squeegee.

We are very pleased with the way the disk is performing. The disk will apply a band of material uniform in width and thickness over the crack. We feel this is doing a much better job of putting the product where it does the most good, and improves the work cosmetically as well.

I do not believe this item can be purchased; however, it can be made in a few minutes with a small amount of welding. First, you need a 30 degree pipe elbow. This should be the same size pipe as the wand, which will usually be 3/4-inch. Second, a proper disk is needed. We found that a conical 4-inch washer works best for us. These are sometimes called a compression washer, and are most commonly used for wooden beam construction. These can be obtained from almost any fastener supplier. To make the attachment, simply weld the elbow to the washer and thread this onto the end of the wand. If the results you get are too wide or too narrow, just vary the sized of the washer.

Another item we are using is an insulated blanket placed over the melter to hold as much heat as possible in the product overnight. The blanket has heat resistant outer coverings similar to vinyl, and a new type of heat resistant insulation sewn inside. This was made to order by a local vendor.

Along this same line, we have found that covering the exhaust vents from the propane burners with a coffee can also helps to hold the heat overnight. Please note: Do not cover these vents unless the burners and propane supply are turned completely off.

Some additional operator tips are to use a boom with limber springs to suspend the applicator hose, and use swivel quick fittings on both ends. This will make handling the hose and applicator a much easier chore by reducing fatigue.

Oregon Roads, Summer 1987, Number 11.

PUBLICATIONS

PAYING FOR GROWTH: USING DEVELOPMENT FEES TO FINANCE NEW INFRASTRUCTURE

Impact or development fees are being used increasingly by communities to raise funds to pay for improvements to roads, sewer and water systems, parks and other public facilities.

Traditionally, one generation of residents benefits from the infrastructure investment of previous generations; only in communities growing more rapidly than the inflation rate are special fees on new development warranted, according to this report published by the Urban Land Institute.

This publication contains an analysis of the types of private financing required for expansion of infrastructure systems, the legal foundation for public requirement, economic effects of these requirements and the administrative procedures necessary to carry out the imposition of development fees.

This report is available for $42.00 from the Urban Land Institute, 1090 Vermont Ave., N.W., Washington, DC 20005.

CURB CUTS

According to the Eastern Paralyzed Veterans Association (EPVA) in a 1982-1983 survey of their wheelchair user members, one of the most frequent responses to a question about individual mobility (by a wide margin) was the lack of sidewalk curb cuts (ramps). In response to this, the Association has produced a manual, Curb Cuts, to supply as much information as possible regarding the design and construction of curb cuts.

Curb ramps in your community will enhance the ease of movement for many more people than just wheelchair users-- for example, people with baby strollers, the elderly, young children, and people with heart conditions. Every state now has a curb ramp law, so why not make sure that your curb cuts are

Continued on page 10
Continued from page 9

designed so that people that they are intended to
help can use them safely. Curb Cuts is available
free of charge from Eastern Paralyzed Veterans
Association, 432 Park Avenue South, New York, New
York 10016.

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IMPROVING GUARDRAIL INSTALLATIONS ON
LOCAL ROADS AND STREETS

This pamphlet, published by the Federal
Highway Administration, is intended as a general
guide to effective, low cost methods of enhancing
highway safety with guardrail. The guidelines and
recommendations included are based on actual situa-
tions and observations found in a series of national
reviews. They reflect the actual needs and oppor-
tunities for highway safety improvements existing on
many local roads and streets.

---

AVOID A BRIDGE
CATASTROPHE

by Charlie Goodspeed

Are you a government official responsible for
posting bridge load limits? Are you reluctant to
install signs advising motorists of load restrictions
for fear that acknowledging the deficiency, but not
correcting it, makes you liable in case of an
accident? Nothing could be further from the truth.
The best defense is posting the limits and maintain-
ing a prioritized list of corrections to be made as
funding becomes available.

What makes a bridge structurally deficient or
functionally obsolete? Structural deficiency results
when the bridge deck, the superstructure, or the
substructure has weakened or deteriorated to the
point that the bridge is inadequate to support all
types of traffic. Functionally obsolete bridges are
those that are structurally sound but are no longer
adequate to serve today's traffic. These are the
bridges that are too narrow, poorly aligned with the
roadway, or have insufficient load-carrying capacity.

Is it unreasonable to expect someone who is not
an engineer to assess the potential liability of a
bridge? No! There are many signs that can be
observed before a catastrophic disaster occurs.

Structural Deficiency: Can the bridge support
all possible types of traffic? We can assume the
bridge was properly designed for today's traffic
unless it is more than 50 years old. To determine
the existence and extent of deterioration of any of
the three main components—deck, superstructure and
substructure—check the following:

**Deck**

A bridge deck supports the wearing surface and
typically made of concrete, wood or steel grating.

**Signs of Deterioration**

- **Concrete Material:** Cracks, loose or deterior-
  ated concrete to a depth where the steel reinforcing
  is visible.

- **Wood Material:** Splits, checks and rot to the
  extent that one can push a sharp pocket knife blade
  into the deteriorated wood to a depth 1/4 of the
  member depth.

- **Grating Material:** Rusted sections or bent
  sections to the extent that the remaining material
  looks smaller than the original.

**Superstructure**

The bridge superstructure is the portion of the
bridge that spans between the supports. The super-
structure beams support the bridge deck.

**Signs of Deterioration**

- **Concrete Material:** Concrete cracking or
  spauling to the extent that the reinforcing is visible.
  Rust stains that originate in the beam. Beam deflec-
  tions that are visible to the eye.

- **Steel Material:** Rusted members where the
  corrosion visible reduces the steel thickness. Rusted
  rivets, bolts and welds to the extent that corroded
  material is separating from the item.

**Substructure**

The portion of the bridge supporting the super-
structure. Sections of the substructure are under-
ground; however, the visible portion supporting the
beams can be inspected from underneath the bridge.

**Signs of Deterioration**

- **Concrete Material:** Most bridges have concrete
  substructures. Concrete cracking and spauling should
  be checked for corrosion and alignment. All abut-
  ment components should be checked for vertical
  alignment and settlement.

- **Functionally Obsolete:** Bridges typically become
  obsolete when the approach roads have been
  upgraded by either widening or realignment.

If any of the above signs of deterioration are
observed, a qualified bridge engineer should be
notified and a complete bridge evaluation done.

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Road Business, Technology Transfer Center,
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THE IMPORTANCE OF SOIL COMPACTION IN ROADWAY CONSTRUCTION

Compaction is the simplest, most economical method of increasing pavement life and improving its load carrying capacity. This article discusses the factors that influence compaction, describes some of the equipment utilized to perform it, and presents some useful guidelines for compacting soils.

The performance of the pavement depends to a large extent on the properties of the layers immediately below the surface. Structural failures on existing pavements often are caused by the inadequate density of the base courses. In order to provide the required strength, reduce future maintenance, and add years to the life of a pavement, the density of the base material has to be increased through compaction. For example, a soil material may weigh less than 100 pounds per cubic foot before compaction and over 140 pounds per cubic foot after compaction. The increase in density improves the following characteristics of the soil:

- increases strength so that heavier loads can be supported,
- decreases compressibility so that smaller settlements can be expected over the life of the pavement,
- decreases permeability,
- increases resistance to rutting.

Factors That Influence Compaction

The two major factors that influence soil compaction are soil type and moisture content. Soil type dictates the relative number of passes required, the thickness of compaction layers, the type of compaction equipment, and the moisture content to achieve proper compaction. Clays are not permeable; therefore, they require much compactive effort to expel air from the voids. Sands, on the other hand, are quite porous and need less compactive effort. Repeated light loads are most effective in compacting clays while a few passes of very heavy loads work best with sand. Clayey soils should be compacted in layers, six to eight inches deep, while sands may be compacted in eight to ten inch lifts.

Moisture content is another important factor in compaction since moisture lubricates soil particles allowing them to be pushed together more easily. Too much moisture keeps particles apart; too little moisture means poor lubrication. At optimum moisture content, proper compaction will yield the maximum density for the soil. Laboratory tests are necessary to determine the relationship between moisture content and density for each material.

Compaction Equipment

Different procedures and equipment are used to compact the types of soils most commonly encountered in the Island: residual/clayey soils and sandy soils.

The compaction equipment depends upon the size of the project and the type of base material. Sheepfoot rollers are most effective on clayey soils, while pneumatic-tired rollers are most effective on sandy soils. These rollers vary in weight between 6,000 and 10,000 pounds for an eight foot width, and up to 75,000 pounds for a 10 foot width. Pressure on the tamping feet vary, but a minimum of 150 pounds per square inch is recommended.

Pneumatic-tired rollers use rubber tires mounted on a frame which places a uniform load on each tire. Compaction comes from the kneading action of the rubber tines. Pneumatic rollers for highway work generally weigh six to eight tons. Pneumatic and steel-wheeled rollers compact from the top downward whereas the tamping sheepfoot roller compact from the bottom up.

Recommendations

Based on the above discussion, some useful guidelines are recommended for compacting soils:

- sample the soil and determine the type (i.e., clay, sand, other) and natural moisture content,
- determine the maximum density and optimum moisture content,
- modify the field moisture content to improve the compaction by adding moisture to the soil if the moisture content is below the optimum value, or by adding dry soil or aerating the existing soil if the moisture content is above the optimum value.
- compact the soil layers at appropriate depths and use the correct type of roller for the soil being considered.
- verify that the soil is compacted at the density specified on the plans and specifications of the project in question.

NEW VIDEO TAPES

The Technology Transfer Center has added five new tapes to its video tape library since the last listing. The tapes may be borrowed, at no charge, for a two week period. Please write or phone and request no more than two tapes at a time. Specify the tapes you want by the number in the left hand column. Please return the tapes promptly.

ST-205  Traffic Control and Tort Liability (50 minutes)
Gives suggestions concerning traffic control devices for local jurisdictions to help avoid tort liability suits.

Tort Liability (60 minutes)
Discusses tort liability and local jurisdiction responsibility with respect to design and operation of transportation facilities.

ST-212  Night Safety at Worksites (12 minutes)
Specifications for providing a safe nighttime environment in construction zones.

Work Zone Flagging (25 minutes)
When and where to use flagging, responsibilities and requirements of flaggers, and proper flagging procedures.

Selection and Use of Traffic Control Devices (30 minutes)
Objectives of work area traffic control and selection of proper control devices.

Introduction to Work Area Traffic Control (30 minutes)
Basic principles of work area traffic control and inputs into selecting proper traffic control.

Partners in Safety (15 minutes)
Describes work area traffic control and how to use it properly to achieve cooperation between the road user, contractor and flagger.

Sample Applications of Work Area Traffic Control (30 minutes)
Devices used as work area traffic control for both mobile or short and long term construction zones.

Speed Zoning by Montana Highway Patrol (30 minutes)
Describes background and misconceptions of speed zoning and the procedures for determining speeds of highways and local roads.

M. JOHN MOSKALUK
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TEST YOUR TORT LIABILITY I.Q.

The following definitions have been taken from the Tort Liability and Risk Management workbook which was prepared for the upcoming short-course of the same name. See if you know the meaning of each term.

Affidavit—a voluntary, written statement made by an individual, which is sworn to or affirmed before a witness or a notary public. A person who makes an affidavit is called an affiant.

Complaint—a form of legal process which usually consists of a formal allegation or charge against a party, which is made or presented to the appropriate court of officer, for a crime that has been committed or a wrong that has been done.

"Deep pockets" theory—describes the condition in which lawyers will involve potential defendants, if the defendants have the available financial resources. It also relates to the enforcement of judgments in the apportioning of awards under joint and several liability.

Defendant—the named entity which is being sued for having allegedly committed a wrongful act. A defendant may be an individual, a municipal corporation, or any other legal entity.

Deposition—an affidavit, oath, or written testimony of a party or witness, given in the course of a judicial proceeding in response to written or oral questions, where there has been an opportunity for cross-examination. An individual who makes a deposition is called a deponent.

Joint and several liability—when it has been determined in a legal action that two or more wrongdoers have jointly caused injury or damage to the plaintiff, the plaintiff may seek enforcement of the judgment against all of the defendants together, some of the defendants, or any one of the defendants. The term thus means that each wrongdoer can be considered to be liable individually or together.

 Judgment—the sentence of the law, for the record, as the facts are applied to the law in the particular case; the ruling of the court and the final set of the proceeding.

Plaintiff—the person who brings an action, suit or complaint; the one who complains of an injury having been done. The plaintiff may be a person, a corporation, or any other legal entity.

Release—the giving up or abandonment of a claim or right to the person against whom the claim exists, or the right to be enforced or exercised.

Summons—a document issued to or served upon a defendant in a civil action, for the purpose of securing his appearance in the court action. The summons usually notifies the defendant that if he should fail to appear within the specified time, a judgment by default will be entered against him.

Tort—an injury or civil wrong, committed with or without force, to the person or property of another. It is a wrong that has been done to the plaintiff, and is actionable in court.

Tortfeasor—a person who commits a tort or is a wrongdoer.
EDITOR'S NOTE

I, for one, am so glad that it is finally spring, and I am sure that you all are happy to have some warm, pretty days in which to work.

Besides the coming of spring, the other big event which is coming up is our series of workshops on right-of-way acquisition. Three workshops will be offered—"Basic Relocation," "Business Moves," and "Decent, Safe, and Sanitary Housing"—in the spring, summer and fall, respectively, of 1988. Brochures for each workshop will be distributed to everyone on our mailing list, so be on the look out for this information so that you can set aside the appropriate dates to attend.

Each of the three workshops is offered independently of the others. In other words, you may attend any or all of the three sessions (but, of course, you are encouraged to attend them all). There is a registration fee of $50 for each session, which should be payable to the Georgia Department of Transportation and presented at the time of the workshop.

The first workshop, which is entitled, "Basic Relocation," will be held throughout May in each of the seven DOT districts. Please see the announcement on page eleven for more details concerning the subject matter and the logistics of the workshop.

I am currently in the process of writing a final report for 1987, and as a result, some interesting information has come to my attention. It seems that many of you are not aware that the Technology Transfer Center is equipped to provide technical assistance and technical materials, in addition to our services of workshops and this newsletter. The level of technical assistance that we offer cannot be competitive with the services offered by consultant or engineering firms, but it can still be of significant benefit to you. (We generally restrict our assistance to projects which can be completed within a two-day period.) The Center also has a vast array of technical materials which might be of benefit to you. If you let me know what specific subject you are interested in, I can sort my library list for that topic. Even if I do not have enough copies to give away, I will certainly loan you a copy of anything that I have.

Please keep all of this information in mind, and make full use of the Technology Transfer Center whenever you can.

Enjoy the pretty weather!

NEWS BRIEFS

Did you know that leaving your car idling and going back into the house while it warms up could lead to a fire in your engine?

The National Highway Safety Administration has cautioned motorists about leaving a cold engine to idle for an extended period of time. The agency explained that when an engine is cold, most vehicles equipped with a carburetor will idle fast while the choke is on until the operator depresses the accelerator pedal to return the idle to normal. If the operator neglects to do this, or is away from the vehicle, the engine may operate too long with the choke on, the catalytic converter could over heat and a fire could result. Due to vehicle differences, NHTSA suggests that drivers consult their owner's manual to determine how long the manufacturer advises that an engine can be idled safely.

To promote the use of methanol and alternative fuels, the Consumer Subcommittee of the Senate Commerce, Science and Transportation Committee is considering legislation (S. 1518) giving automobile manufacturers credit toward meeting fuel efficiency standards for the production of cars that run on alternative fuels. Also, the President's Task Force on Regulatory Relief has recommended that alternative fuels be exploited to upgrade air quality and cut dependence on foreign oil.

Rural economic development initiatives have been proposed in bills in the House and Senate (S. 1729 and H.R. 3371). The legislation, introduced by Sen. Patrick Leahy (D.-Vt.) and Rep. Ed Jones (D.-Tenn.), provides funds for infrastructure improvements for local governments.

A Japanese company is marketing a device that is said to maintain alertness by cooling the driver's forehead. The Drowsiness Stopper consists of a headband with a flat aluminum plate in the front attached to a wire that plugs into any standard cigarette lighter. The plate contains a semiconductor thermoelement that is said to produce a cooling sensation. According to the president of the company producing the device, the idea came as the result of research at Tokyo Kyoiku University showing that maximum alertness and concentration was achieved by a combination of warm feet and a cool head.
Undoubtedly one of the most useful of all temporary warning and lane-marking devices is the familiar rubber cone. Unfortunately, cones tend to be tipped over and knocked about fairly easily by passing traffic. Now a Chicago manufacturer has come out with a device that combines the idea of a traffic cone with that of a child’s punching toy. Burke’s inflatable Safety Cones have rounded, weighted bottoms like the punching toy. When knocked over, they pop right back up again. The top portion of the cone is inflated like a beachball and is made of a tough plastic material that is said to be resistant to puncture and returns to its original shape when run over. The tips are coated with a reflective glass-bead material for nighttime visibility. The inflatable feature makes for easy storage when not in use. The cones, which can be used both as emergency markers during a vehicle breakdown and for marking road construction zones come, in both 18-inch and 28-inch sizes.

A paving system developed in Sweden incorporates rubber particles into asphalt pavement. The pavement surface is more flexible so that traffic breaks and knocks aside ice on the roadway. Rubberized pavement also increases skid resistance and durability. The pavement system is distributed in the U.S. under the name "Plus Ride."

The Alaska Department of Transportation tested the pavement and found that the use of rubber particles offers significant advantages when the pavement is properly placed and used in the proper location such as bridge decks.

An interesting spinoff is that it provides a use for waste tires.

The corrosion of reinforced concrete bridge deck and elements, aggravated by the use of road salts, represents a world wide problem. An R&D program sponsored by West Germany’s Research and Technology Ministry has now come up with fiberglass elements that are totally impervious to corrosion.

The high performance fiberglass plates and reinforcement rods developed under the R&D program since 1980 have now been installed in two Duesseldorf bridges, the larger of which has a span of about 150 feet. They are currently undergoing performance testing. Optical fiber sensors have been installed in the bridges to monitor the new elements which are said to be a world first, pointing the way to a resolution of the corrosion problem in future infrastructure projects. The larger of the two bridges—a highway overpass—has been in service since last summer.

The Federal Occupational Safety Health Administration has announced changes to its construction industry compliance policy that reemphasize employers’ on-site safety programs.

OSHA said that when construction inspections are conducted, a safety and health program evaluation will be completed paying special attention to management commitment and leadership; assignment of responsibility for the program; identification and control of hazards; training and education of supervisors and employees; hazard analysis and recordkeeping; and first aid and medical assistance.

Additionally, safety and health program deficiencies will be discussed with the employer and violations of instruction requirements, first aid, recordkeeping and identification and control of hazards will be cited.

A zip code can save hundreds of dollars: over one-third of all sign vandalism is attributed to theft. The use of “Loc Tite” cement adhesive on sign mounting nuts and bolts has been reported to be one of the most effective means of reducing sign theft. But what can you do if signs get stolen?

Garth Witty, Road Agent for Mont Vernon, NH gets about 30% of all his stolen signs back. How does he do it? By engraving his town’s zip-code on the back of the sign where it attaches to the posts. Any recovered sign from Mont Vernon can be identified.

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HARD HATS

The subject of head protection has a rather interesting history. Safety hats as we know them have been around for some 60 years, but protective headgear is a lot older than that.

In the old days, soldiers would wrap pieces of leather or metal strips around their heads for protection. Vikings made their leather helmets and Roman soldiers used polished metal helmets for protection against the blows of the enemy. Who knows, even the caveman may have thrown a turtle shell on his head for protection against the clubs of neighbors.

Protective headgear was forgotten for a few centuries until World War I, when it reappeared as the doughboy hat. Somebody had finally figured out the helmet could take the flying debris a lot easier than a man’s head. After the war, the same helmet was modified for industry and became the safety hat.

Safety hats, more commonly called hard hats, come in two models: (1) the cap which has a bill on the front, and (2) the hat which has the full brim. The hat weighs 2 to 3 ounces more than the cap, but the balancing factor makes it impossible for a blindfolded person to tell the difference. What’s more, the full brim offers better protection from the sun and rain.

It is important that the inner suspension be properly adjusted. The webbing and band should both be securely on your head and adjusted so that you can bend over without the hat falling off. The new ratchet adjustment helps by allowing a more accurate and faster adjustment.

By the way, chin straps are available on contract to afford maximum protection. Think of the limited protection a football player would have without a chin strap on his helmet. Several injuries are reported each year wherein hard hats are knocked off and head injuries occur as a result. Remember, a hard hat cannot protect you if it is not on your head.

In addition to cushioning blows, your hat can protect against electric shock, chemical spills, or hot materials.

WHEN TO WEAR HARD HATS

FOR WORK:

* On or adjacent to the traveled portion of the roadway (generally the right of way).
* In contractor’s hard hat zones.
* While operating heavy equipment.
* Where there is danger of head injury from impact, falling, or flying objects.
* Where there is danger of contact with a high voltage electrical source.

CARE AND MAINTENANCE

Periodically, check the shell for cracks and the suspension system for cracking, tearing, or fraying. Never paint, drill holes, or use solvents on your hard hat because they weaken the shell. Use soap and water. As a general rule, the entire hat should be replaced every two years.

DON’T LOSE YOUR HEAD OVER FALSE OBJECTIONS

Here are some answers to questions and comments most commonly heard.

* “Why all the emphasis on hard hats?”

Remember, the brain is the control center of the body. The slightest damage to any part will cause a malfunction of some area of the body, either temporarily or permanently. The skull, under normal circumstances, protects the brain, but when the possibility of brain damage from outside sources exists, additional protection is required.

* “My hard hat is too hot in the summer.”

Tests in hot weather have shown that the temperature inside a hard hat is 12 degrees cooler than a baseball style cap. Your head is kept cool because of the ventilation provided by air spaces between the shell and the suspension. The hat’s surface reflects the heat too.

* “My hard hat is too cold in the winter.”

Liners that come down over the ears are readily available for cold days. Hard hats must not be worn
on top of everyday hats or parkas, and of course, you must not remove the suspension.

* "My hard hat is too heavy and strains my neck."

The weight of the hat should go unnoticed if the hat is properly worn and maintained. The average safety hat weighs about 13 ounces. Your head weighs about 13 pounds. That is one ounce of protection for every pound of head. It's a real bargain!

(Adapted from "Bulletin," Washington State Department of Transportation)

MAINTENANCE TIPS

LEVELING WITH PREMIX

Leveling is required when there is rutting or corrugations.

Rutting is a longitudinal depression that forms in wheel paths. It is caused when pavement is permanently deformed under traffic. It normally occurs in wheel paths of a new pavement due to improper compaction during construction or in wheel paths of older pavements because of inadequate thickness for the traffic volume on the road.

Corrugation is pronounced ridges and valleys (ripples) occurring less than 2 feet apart, crosswise to the direction of traffic. This distress is sometimes referred to as "washboarding." Corrugations are normally caused by unstable mixes produced by a) an excess of asphalt, b) an asphalt cement that is too soft a binder, c) a mix with too many fines in the aggregate, or d) a mix with rounded aggregate. Corrugations normally occur where a bump causes vehicles to spring or where there is braking and acceleration of vehicles such as at intersections.

Crew required for leveling with premix:

| Equipment operators | 3 |
| Truck drivers       | 3-5 |
| Rakemen             | 2 |
| Laborers            | 2 |
| Flagmen             | 2 |
| **Total**           | 12-14 |

Equipment required:

- Dump trucks: 3-5
- Distributor truck: 1
- Roller: 1
- Power broom: 1
- Motor grader: 1
- Asphalt spreader: 1

Material required:

- Hot premix asphalt concrete
- Liquid asphalt tack coat

Repair procedures:

1. Place signs and other safety control devices.
2. Clean loose material off surface with power broom.
3. Apply light uniform coat of tack material covering entire surface to receive leveling course.
4. Spot dump premix from trucks along area to be leveled.
5. Spread premix with motor grader; layers should be less than 3 inches thick.
6. Hand rake excess premix over the butt joints and feather the edges.
7. Roll each layer of premix immediately after spreader.
8. Clean loose materials from roadway with power broom.
9. Clean up area and remove signs.

COMPLETE OVERLAY WITH PREMIX

Complete overlay is required when there is extensive cracking or potholes, or insufficient roadway profiles.

Potholes are small (less than 3 feet in diameter) depressions in the pavement surfaces. They are normally irregular in shape, have sharp edges, and vertical sides near the top. Potholes are usually caused by poor design practices such as too thin of
SHOP-BUILT RURAL BRIDGES

Oklahoma Uses Precast Short Spans to Cut Costs, Ease Installation

Research in Oklahoma into short-span bridge design has produced a precasting technique that promises stronger replacement bridges at reduced costs and construction times—all with typical county highway department labor.

The program's sponsors include Stephen C. Lewis, a state legislator and principal author of funding for the research; James E. Shamblin, Director of the Center for Local Government Technology at Oklahoma State University-Stillwater, which performed the research; and J. D. Paden, OSU-Stillwater Extension Engineer. Pottawatomie County Commissioner James Craven supervised most of the initial construction, and Roger J. Driskill, a regional engineer for Portland Cement Association, provided technical assistance.

Since 72 percent of the 15,174 bridges in Oklahoma's county system are rated structurally deficient or functionally obsolete, it was an appropriate site for research into better ways of designing and building rural bridges. Even though Oklahoma's bridges qualified for repair or replacement cost-sharing under the federal off-system program and Oklahoma's county bridge improvement program, funds were inadequate to replace the ailing bridges using standard designs and techniques.

SIMPLIFIED DESIGN

The issue before OSU-Stillwater's Center for Local Government Technology, one of FHWA's Technology centers, was how to make existing funds and expertise go farther. The goal was simplified design and construction of short span bridges.

The solution was a system of prefabricated, reinforced concrete beams using a modified double-T cross section with no prestressing. The girders were placed side by side to obtain the desired roadway width and bolted together with one-inch tie bars. Keyways left between the girders were grouted from the top of the deck with a high-strength epoxy or high density concrete grout to meet AASHTO standards. This system yields an HS-20 load rating. Most bridges replaced under the program had a five-ton load limit.

The illustration shows the placement of reinforcing steel in the beam. Tensile strength is developed through the cluster of three No. 10 bars in the loop at the end of the shear bar. The shear bars are on six-inch centers throughout the 25-foot length of the beam.

Three circular bores are provided so the beams can be bolted together. They appear in the illustration as dashed lines, ending in a notch that provides a flat surface to hold the bolt. The four circles at the top of the drawing represent reinforcing bars running perpendicular to the shear bars through the length of the beam.

Note the notch at the top corners of the beam. The top is one inch narrower than the body of the girder. When two beams are placed together, a two-inch-wide shear blockout is created between adjoining beams. When filled, it forms a shear key that transfers load and helps prevent one beam from moving independently of the other.

The first three demonstration bridges use bare steel, extension engineer Paden said. Future bridges probably will use epoxy-coated steel. The design originally called for Grade 40 steel, but Paden said it was changed to Grade 60 to compensate for the lightness of the beams while maintaining the objective of heavy load capacity.

"We designed this bridge according to the same loading criteria as the interstate system, but with much lighter beams," Paden said. "That's why we went to heavier steel."

DESIGNED FOR 20-25 FEET

Paden emphasized that the design was not intended for bridges longer than 25 feet. He doubts that most counties will want to use it for spans shorter than 20 feet, because they would not meet the minimum length criteria to be classified as a bridge and thus would be ineligible for state or federal cost-sharing.

An important aspect of the design is that the beams can be prefabricated with reusable steel forms that county crews can create from standard structural shapes.

The benefits are substantially reduced material costs and construction time. Beams can be built in winter or off times in county maintenance yards and stockpiled. When an old bridge has been removed and new abutments completed, the beams can be hauled to the site and set in place.

JIG TABLE AVOIDS ERRORS

Paden estimates the cost of the reusable steel forms at about $4,300 a pair. To ensure correct placement of the reinforcing steel, the university suggests use of a template (jig) table with notches...
and stops. The risk in working with inexperienced crews is that they might misplace or leave out bars, thus weakening the bridge.

The jig table used by Pottawatomie County is built of channel iron. The reinforcing steel is laid in the notches. When all the notches are filled, the bars are all in their proper places. The table is dimensioned such that if a bar is too long or too short, it will not fit.

When the bars are installed, the whole basket is hoisted into the form. After clearances are verified, a 3,500 psi transit-mixed concrete is poured into the form. Each girder requires about 2.75 cubic yards of concrete. Pottawatomie County pours two beams a time, leaving them in the forms until flexural strength specimens indicate 550 psi.

Finish of the upper surface is left rough because it will be the roadway. The two outside beams will have steel plates flush with their sides and anchored with welded U-bolts for guard-rail posts.

"The system is foolproof," Paden said. "Everything either fits or it doesn't. If it fits it's right."

PCA's Driskill agreed. "The system is unique in that it allows the county the latitude to schedule work as time and manpower permit," Driskell said. "The entire operation can be completed in minimum time with minimum personnel."

The girders are stockpiled until there are enough for a bridge. Eight girders usually are required. They are hauled to the site on a low-boy trailer. A county road department can pour a yardful of girders during the winter and have them ready for the spring floods.

TEST BRIDGE COST $30,600

The bridge selected for the first test is four miles west of Shawnee. County crews removed the old bridge, materials for new abutments were purchased, and a contract was let for labor and equipment to drive pilings.

Vertical wall, sheet piling type abutments with HP 10 x 42 bearing piles and 45 degree wings were constructed. Then the prefabricated deck was hauled to the site and erected in less than a day.

Total cost of the pilot bridge was $30,600, not including the cost of the forms.

"This represents very little savings over a concrete box of comparable opening," Paden said. "However, on the first bridge there was considerable wasted motion since everyone was inexperienced. This, coupled with unusually deep bedrock-bearing piles were 43 to 45 ft. long—elevated the cost."

Nevertheless, the university believes strongly that the design can produce savings of at least 15 percent over conventional designs. State and county officials share this confidence. Two similar bridges are under construction, one in Pottawatomie County and another in Osage County, and a fourth is planned.

Osage County Commissioner Harold Muman sees more than financial advantages. "If I have some of these beams in the yard when one of those overweight oilfield trucks breaks all the stringers on a wood deck, I can grab four or five of the beams and have that bridge open for school buses the next day," Muman said.

(Reprinted from "Arizona Roads," October, 1987)

Continued from page 8

Experience has shown Riverside's Street Maintenance Department that the best production of their entire cutout and patch crew is gained when all pavement scheduled for replacement in a single day is outlined for the cutter wheel at the outset of the day's work. The loader then handles all pavement removal, leaving the area free for the paving crew. Following this sequence, it is not uncommon for the cutout and paving crew to remove and replace 10,000 sq ft of distressed asphalt in a single day, using only the loader, supporting dump trucks and the paving spread.

What does Clelland do with all the time saved by this novel use of the loader? "We send the loader down the rural roads to clean up palm fronds and help with drainage repair, then run it out to our pit for material loading. The pavement cutter hasn't cut back on the amount of work we have to do. It just lets us do it more efficient."

(Reprinted from "Roads & Bridges," May, 1987)
Riverside, California, adds shop-designed and fabricated pavement cutter wheel to multi-purpose bucket; loaders does double-duty

The Public Works Department of California's city of Riverside has found a unique way to remove distressed asphalt pavement. They added a shop-designed and fabricated pavement cutter wheel to the bucket of a new wheel loader. Now the loader and a dump truck alone take care of all pavement cutout and removal work.

"It's fast, precise and quiet," said Dick Clelland, senior street maintenance supervisor for Riverside's Public Works Department. "We're doing more work with less equipment and fewer people."

Residents of the neighborhoods in which Riverside's repair crews frequently work will add that street repair is no longer accompanied by the noise and clutter of pavement breakers and jackhammer crews.

For Riverside's Street Maintenance Department, a nimble front end loader has always been the pivotal machine for street repair and maintenance work. On an earlier loader, they perfected a pavement cutter wheel addition to the loader bucket. They have further perfected the device and have it installed on the backside of their loader's new multipurpose bucket.

A big part of Dick Clelland's street maintenance work involves repairing old oil and asphalt streets, many of them dating to the first residential boom period of the 1950s. In some areas deterioration of the asphalt binder has caused the roadway to crack and ravel. In other areas, waterlogged roadway base has given way. Whatever the cause, the remedy is the same: remove the damaged pavement section and in some instances reconstruct the base, then send in the patch crew.

With the growth of Riverside—the one-time orange grove community is now a growing city of 170,000 with 720 miles of mostly asphalt streets—the amount of time devoted to street patching has skyrocketed, not accounting for nearly half of the Street Maintenance Department's budget.

Clelland's department, recognizing that sections for removal were wasting time and aggravating surrounding residents and businesses, decided that a cutter wheel attached to the bottom of a wheel loader's bucket could simplify life for everyone. Even in its prototype stage on an older, smaller loader, it worked so well that a local contractor first rented Riverside's machine, then copied the pavement cutter and now uses it on his own loaders.

The 14-in.-diam steel disc cutter is installed in a modified scarifier tooth. A steel socket for the tooth was welded to the heel of the bucket, where a steel pin holds the wheel strut in place.

The earlier version of the wheel assembly was permanently installed on the loader bucket. When the new loader was purchased, a Caterpillar Model 936, the wheel assembly was redesigned to allow the wheel to be removed from the socket so it doesn't interfere with loader bucket operation. A hand-operated cable winch installed on the rear of the bucket permits fast and easy installation and removal of the cutter wheel.

In operation, the pavement cutter is pressed into the asphalt surface by hydraulic downpressure and weight of the loader's bucket. A slight rocking is often required to initially break through the surface crust. Once down to full cutting depth of 6 inches, the cutter wheel is in business and works just like a pizza cutter, with the loader operator following the outline of a cutout spray-marked on the pavement. Where the pavement is particularly hard or thick, added pressure on the wheel is gained by filling the loader bucket.

The 40° articulation and good operator visibility of the wheel loader is a big help to Riverside's street crew, particularly on narrow residential streets or busy arterials. It permits quick execution of the cross cuts at the end of each cutout.

In order to speed cutout work and provide the clean pavement edge needed for good patch work, cutouts are always made at least as wide as the loader bucket. The removal of the outlined section of the distressed pavement then requires only loader bucket work, with modest hand shovel cleanup at the ends of the cutouts.

The multi-purpose bucket is considered essential for this work by Clelland. Its clam action makes short, easy work of handling large pieces of pavement, and for cleanup at the ends of the cutouts. The bucket is also a help when unstable base must be removed. Again, the short turn radius of the articulated is critical to material handling and truck loading on small and busy streets.

Continued on page 7
an asphalt surface, poor drainage, or inadequate base. Potholes are liable to occur in any location. Further localized distress such as alligator cracking can quickly develop into pot holes when water is present.

Poorly designed or constructed roadway profiles allow water to pond on the pavement due to insufficient crown and/or low points in the pavement grade. Insufficient roadway profiles are caused by improper techniques in placing the pavement surface or inadequate design for drainage. They are normally found on old section of road, but may occur on roads recently resurfaced.

Crew required for complete overlay with premix:

<table>
<thead>
<tr>
<th>Crew Required</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment operators</td>
<td>3</td>
</tr>
<tr>
<td>Truck drivers</td>
<td>3-5</td>
</tr>
<tr>
<td>Rakers</td>
<td>2</td>
</tr>
<tr>
<td>Laborers</td>
<td>2</td>
</tr>
<tr>
<td>Flagmen</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>12-14</strong></td>
</tr>
</tbody>
</table>

Equipment required:

- Dump trucks: 3-5
- Distributor truck: 1
- Roller: 1
- Power broom: 1
- Asphalt spreader: 1

Material required:

- Hot premix asphalt
- Liquid asphalt tack coat

**Repair procedure:**

1. Place signs and other safety control devices.
2. Close the lane being repaired to traffic.
3. Clean loose material from surface using power broom.
4. Apply a light but uniform covering of asphalt tack material from distributor truck.
5. Spread mix in place with asphalt spreader; no lift should be placed that exceeds 3 inches in thickness; care should be taken to assure proper roadway profile (e.g., a crown greater than 1% and no low spots in pavement).
6. Rake edge of pavement to prevent sudden drop off.
7. Roll each layer immediately after placement.
8. Repeat for other lanes as necessary.
9. Broom area to remove loose materials from roadway surface.
10. Clean up area and remove signs.

**PANEL REVIEWS STATE TRUCK AND BUS REGULATIONS**

The Commercial Motor Vehicle Safety Regulatory Review Panel, an important but little-known advisory group to the Federal Highway Administration, is quietly at work at its massive statutory task of reconciling all state truck and bus safety regulations with the Federal Motor Carrier Safety Regulations. The goal of the panel is to improve highway safety by removing the confusion and frustration truck and bus drivers experience when operating between states.

In December, at its fifth meeting since being formed in 1986, the group approved the format for notifications that will be sent to every state governor calling attention to broad areas in which individual state laws or regulations are different from their federal counterparts.

The governors’ comments will be assimilated in a report to the Secretary of Transportation in September of 1988 by the Safety Panel, with its recommendations. In turn, under terms of the underlying Motor Carrier Safety Act of 1984, the individual states have until October 30, 1989, to bring them into conformity. After that, any state law not compatible with corresponding federal laws or regulations may not be in effect and enforced.

The panel had previously received information from all the states and the District of Columbia showing a total of 71,000 state truck and bus safety regulations. Of those, some 43 percent were found to be not equivalent to federal regulations. It is that group that is the subject of the correspondence for the governors.
Improperly mounted mailboxes are responsible for a significant number of accidents and injuries on roads and highways each year.

It is estimated that there may be as many as 20 million mailboxes on rural roads and streets and over 10 to 15 million mailboxes on suburban roads. Because most accident record systems do not include accidents associated with mailboxes, there is limited data suggesting that possibly 70 to 100 people die annually in the United States in vehicles striking mailboxes where the design of the mailbox and its support can be shown to have contributed to the severity of the accident.

The typical single mailbox installation mounted on a 4 x 4 inch wooden post or a 1.5 inch diameter sleeve is not a serious threat to motorists such as the massive structures, such as masonry walls, railroad ties, tractor wheels, plows, concrete filled barrels, etc. that are used to support mailboxes. These turn the installation into a lethal roadside obstacle.

The grouped or multiple mailbox installation is a serious threat to the unfortunate motorists who are involved. The horizontal member in these installations, usually a timber plank supporting the group of mailboxes, is poised at windshield height and, when struck, has impaled or decapitated motorists.

Careful erection of mailboxes can markedly cut down on this type of accident. Mailboxes should be placed along the horizon line, making them much more visible to oncoming traffic. Second, the mailboxes should be mounted on one-post supports which usually inflict less damage to vehicles striking them than two-post or cement supports.

Further guidelines for erecting mailboxes are found in the American Association of State Highway Officials (AASHO) publication A Guide for Erecting Mailboxes on Highways. To order this guide, send $4.00 plus $1.25 postage and handling to: AASHO, Publications, Suite 225, 444 N. Capital at NW, Washington, DC 20011.

(Reprinted from KUTC newsletter of The University Kansas Transportation Center.)

TEN COMMANDMENTS FOR GOOD ROADS

Public officials who have the responsibility for ensuring that the most effective use is made of public funds for constructing roads should make a concerted effort to guarantee that the following rules are used in designing and constructing the roads. Abiding by these rules will produce a high quality road that provides a smooth riding surface for a long time with only a minimum amount of maintenance expense.

1. Get water away from the road.
2. Build on a firm foundation.
3. Use the best soils available.
4. Compact the soils and pavement layers well.
5. Design for traffic loads and volumes.
6. Pave only those roads that are ready for paving.
7. Build from the bottom up.
8. Consider maintenance requirements when designing and constructing the road.
9. Protect your investment.
10. Keep good records.

(Adapted from: Transportation Information Exchange News, St. Michael's College, Winooski, Vermont)

ACKNOWLEDGEMENT

The Technology Transfer (T2) Program is a nationwide effort financed jointly by the Federal Highway Administration and individual State Departments of Transportation. Its purpose is to translate into understandable terms the latest state-of-the-art technologies in the areas of roads, bridges, and public transportation, to local and county highway and transportation personnel.

The T2 Center at Georgia Tech is sponsored by the Georgia Department of Transportation and provides information and counsel to more than 500 municipalities and counties in our state. This newsletter is designed to keep you informed about new publications, new techniques, and new training opportunities that may be helpful to you and your community. Individuals wishing to receive future copies of this newsletter at no cost may send their requests to:

M. John Moskaluk
Technology Transfer Center
School of Civil Engineering
Georgia Tech
Atlanta, Georgia 30332

(Reprinted from KUTC newsletter of The University Kansas Transportation Center.)
WORKSHOPS

RIGHT-OF-WAY ACQUISITION
BASIC RELOCATION

The Technology Transfer Center is sponsoring a series of three workshops on right-of-way acquisition. The first workshop is entitled, "Basic Relocation."

This course is designed for the new right-of-way agent and for the experienced employee whose background has been limited to other right-of-way disciplines. This course will provide additional insight and answer three basic questions about the relocation program: 1) WHEN, 2) WHERE, and 3) HOW.

The registration fee for this one-day workshop is $50.00 per person. The fee should be made payable to the Department of Transportation and presented on the day of the workshop.

The workshop will be presented in all seven DOT districts in the auditorium of the district office. The dates and locations are as follows:

<table>
<thead>
<tr>
<th>DATE</th>
<th>LOCATION</th>
<th>PHONE NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 10</td>
<td>District 5, Jesup</td>
<td>(912)427-9808</td>
</tr>
<tr>
<td>May 12</td>
<td>District 4, Tifton</td>
<td>(912)386-3300</td>
</tr>
<tr>
<td>May 17</td>
<td>District 3, Thomaston</td>
<td>(404)647-882</td>
</tr>
<tr>
<td>May 18</td>
<td>District 2, Tennille</td>
<td>(912)552-7311</td>
</tr>
<tr>
<td>May 24</td>
<td>District 1, Gainesville</td>
<td>(404)532-5526</td>
</tr>
<tr>
<td>May 26</td>
<td>District 6, Cartersville</td>
<td>(404)382-3120</td>
</tr>
<tr>
<td>May 31</td>
<td>District 7, Chamblee</td>
<td>(404)986-1011</td>
</tr>
</tbody>
</table>

Please register no later than one week prior to the date of the presentation that you wish to attend.

Contact the Technology Transfer Center (1-800-282-1275 or 404/894-2360) to register or if you have further questions.

PILOT TIMBER BRIDGE CONFERENCE
CHARLESTON, W.V.
May 11-12, 1988

The West Virginia Municipal Street and Highway Information Program announces a pilot Timber Bridge Conference to be held at the Charleston House Holiday Inn, Charleston, West Virginia. The conference will explore the advantages to municipalities of constructing timber bridges on roads that have relatively low volumes of traffic. Timber bridges have already been constructed in other states at significantly lower costs than bridges made from traditional materials, such as steel and concrete.

Municipal officials who are in a position to make decisions on installation and replacement of bridges will want to attend, as will engineers and manufacturers and treaters of lumber. The conference will address: 1) design, construction, and maintenance of modern timber bridges; 2) the need for, cost comparisons, and practical experiences in using timber bridges; and 3) the suitability and treatability of native timber.

The conference registration is $100 prior to April 29 and $125 after that date. The registration fee includes course materials, breaks, and meals. Please make check payable to "WVU Foundation."

Requests for further information and/or registration should be addressed to: West Virginia University Conference Center, 704 Knapp Hall, Morgantown, WV 26506-6031.

PUBLICATIONS

The following publications are available from the Technology Transfer Center at no charge. Call or write the Center to obtain these materials.

MAINTENANCE AND HIGHWAY SAFETY HANDBOOK

Highway agencies must view with concern all highway conditions which may cause accidents or increase their severity and take immediate corrective action. Much of this work must be done by maintenance personnel as a part of routine highway maintenance.

Many highway maintenance organizations today recognize a need to develop an awareness of safety in all personnel. Toward these ends, this pocket handbook has been developed. It presents illustrations and narrative examples of roadway hazards and scenes of good and bad maintenance operations. It is intended as a reference guide for maintenance crews to interest them in watching for and reporting roadway hazards; preventing accidents caused by improper highway maintenance; and using proper safety devices to protect workers and the public in maintenance work areas.

Continued on page 12
Continued from page 11

RATING UNSURFACED ROADS

About two-thirds of the highways in the United States and 90% of all roads worldwide are unsurfaced or lightly surfaced low-volume roads. Many systems are being used to manage the maintenance of these roads. This manual describes a method that can help local highway agencies manage their unsurfaced roads. The result of the system is a rating for each section of road indicating how badly that section needs repairs.

An unsurfaced road is any road that does not have portland cement concrete, asphalt concrete or any other surface treatment. Some agencies consider gravel to be a surfacing materials; for the purposes of this manual a gravel road is an unsurfaced road.
CONTROLLING THE EFFECTS OF UTILITY CUTS

Utility street cuts that are not sufficiently restored make maintaining smooth street surfaces even more difficult. To combat this problem, it is important that local governing bodies develop and enforce ordinances for use of its right-of-way by utilities.

The ordinance must be explicit and uniformly applied to municipal agencies as well as contractors. Here are some guidelines for developing a sound utility-cut ordinance.

First, all work conducted within a city's right-of-way should require a permit prior to construction. Plans should be required with each request involving a street cut or utility installation. Fees can be based upon the project size or a flat fee may be assessed. Since processing paper work takes time, the utility company must know the advance notice needed prior to construction as well as the specifications to be met. In addition, emergency-cut procedures should be identified and suitable traffic-control procedures outlined.

Bonds can also be issued. The amount should be based upon the potential for road damage. The bond should remain in effect for two years to ensure proper restoration of the road.

Specifications should be developed by the locality outlining regulations on pavement cutting, type of backfill material allowed, minimum compaction standards, restoration of subbase, and paint and identification.

Restoration will be no better than the inspection effort. The specifications must be followed when inspecting a site. The permit should include a clause declaring the utility owner responsible for adherence to the local standards. A good policy is to require notification 24 to 48 hours prior to the work. Follow-up inspections should be made six to 24 months after the repair. Also, document all inspections.

Target dates should also be set for compliance. If work is not completed satisfactorily, the necessary repairs should be made and billed to the utility. If they do not pay for the repair, the performance bond can be used to defray the repair expenses.

There are several potential problems that should be recognized. First, when the utility requesting and making cuts is owned by the local government, discretion should be used in deciding if a permit is required, how to enforce the specifications, and who will conduct the inspections. Second, visual inspection of the compacted backfill is an inadequate practice. Density tests by an independent firm should be a routine check, the cost to be paid by the contractor.

To prevent a newly-paved street from being ripped up two months later for utility installation, utility cut operations should be coordinated with resurfacing efforts. Finally, if there are many patches required, the assigning of color codes to utilities may help in identifying who is responsible for each utility cut.

A little planning may save big headaches later.

From KUTC Newsletter, The University of Kansas Transportation Center, Vol. 10, No. 1, February 1986.
EDITOR’S NOTE

A total of 118 persons attended the Right-of-Way Acquisition Workshop on Basic Relocation which was held in May. We feel that the attendance should have been higher for such a key topic. The issues involved in right-of-way acquisition are becoming increasingly complicated, and local personnel need to keep up-to-date on the facts.

Please make a special note of the announcement on page 11 concerning the next workshop on right-of-way acquisition. The topics for the fall course will be "Decent, Safe, and Sanitary Housing" and "Business Moves." The importance of your awareness of the proper methods and requirements for right-of-way acquisition cannot be stressed enough. Please register as soon as possible for the workshop in your district.

Commissioner Rives and the Technology Transfer Center are in the process of attempting to assess the impact of the Center in Georgia. Evaluation questionnaires have been distributed to county commissioners for their subsequent distribution to officials in their counties. If you received one of the questionnaires and have not yet completed it, please complete it and return it to Commissioner Rives as soon as possible.

PUBLICATIONS

"Financing Infrastructure: Innovations at the Local Level" was prepared for National League of Cities (NLC) by Apogee Research, Inc. The 140-page book is intended to help municipalities understand and handle local capital finance. Twenty-four case studies illustrate various financing techniques. Copies are $10 to NLC members and $15 to non-members plus postage. To order, contact NLC, 1301 Pennsylvania Avenue NW, Washington, DC 20004; phone 202/626-3000.

"Rating Unsurfaced Roads: A field manual for measuring maintenance problems" describes a method that can help local highway agencies manage their unsurfaced roads. The result of the system is a rating for each section of road indicating how badly that section needs repair.

The manual was prepared by the U. S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory and is available from the Technology Transfer Center at no charge.

NEWS BRIEFS

The final Transportation 2020 forum has been held. Thousands of people spoke at more than 60 forums. Transcripts are put into a computerized information-retrieval system to aid in preparation of the national summary report scheduled for release in June. According to Les Lamm, Chairman, Advisory Committee on Highway Policy, the committee's work is largely over and Transportation Alternatives Group will take the lead in identifying policies and financing.

Secretary of Transportation Jim Burnley announced that a permanent office of safety will be created within the Department of Transportation. Designated the Office of Safety Program Review, the new department will conduct independent in-depth reviews of the effectiveness of safety programs. It will review how well previous recommendation have been implemented by DOT administrations and serve as a focal point for directing special safety initiative by the Secretary.

The news office is a descendent of the Safety Review Task Force, which has operated since 1983 as an adhoc group. The office will report to Carolina L. Mederos, the recently appointed Deputy Assistant Secretary for Safety, serving under the Assistant Secretary for Policy and International Affairs.

Residents of College Park, Georgia are so in love with the new 33 mph speed limit that they are taking them home with them. The City Council voted to drop the limit from 35 mph to catch the attention of speeders. The signs went up, and two were stolen within a week, apparently as novelties.

"I think 33 will be noticed more than 35—people will pay more attention to it," said Councilman Thomas Waller, who proposed the new limit.

Waller said he got the idea from a town in Tennessee that has speed limits of 43, 33, and 23 mph. Waller said he does not remember the name of the town, but he does remember its speed limits. That is the whole idea, he said.

On May 17, Adams County, Colorado, Voters approved annexing 45 square miles of land for a new international airport that will replace Denver's Stapleton International Airport—the fifth busiest in the U.S. with 35 million passengers per year. The new airport will be the first major one planned since
Dallas-Fort Worth opened in 1974 and will be the world's largest in square miles. The target completion date for the $3 billion airport is 1993.

The Federal Aviation Administration predicts that it could become the nation's second busiest airport, behind Chicago's O'Hare, because of its strategic location between Europe and the Pacific Rim. The airport is expected to serve 72 million passengers by the year 2000.

Emergency medical services (EMS) personnel should be required to wear safety belts and to comply with traffic signals and speed limits, according to researchers at Vanderbilt University's School of Medicine. A study headed by Paul S. Auerbach, M.D., analyzed 102 ambulance accidents that occurred in Tennessee between 1983 and 1986. One death and 65 injuries were sustained in the 29 most severe crashes.

The team found that failure to use belts was the most important factor in determining injuries among ambulance personnel. "More than half of the ambulance drivers and front-seat passengers were not wearing a restraint at the time of the accident in spite of a clear regulation and medical professional attitudes toward such activity," Auerbach and his colleagues said in a report in the Journal of the American Medical Association.

"Equally distressing is the observation that passengers in the rear of the ambulance, notably the patients or attendants located on the stretcher or sitting on the bench, were unrestrained." While 13 of 52 unrestrained ambulance drivers were injured, only four of the 48 restrained drivers were hurt. Nearly all of the 18 persons with moderately severe injuries were not using restraints.

Urging that ambulance drivers should be required to comply with traffic rules and speed limits, the team noted that loose interpretation of what constitutes an emergency has given these drivers "carte blanche to operated their vehicles as they see fit."

Secretary of Transportation Jim Burnley announced a proposal which would allow truck and bus operators to use onboard recording devices that automatically monitor vehicle and driver information. The proposal would allow a variety of devices, ranging from a basic recording device to a more sophisticated computer system, to be installed in trucks and buses and used instead of handwritten records. If you wish to comment on the proposal, contact FHWA. Comments should be referred to FHWA Docket No. MC-130 and sent to FHWA, Room 4232, HCC-10, 400 Seventh Street SW, Washington, DC, 20590.

Unnecessary and obsolete signs confuse and annoy drivers, may give a false sense of security, and can breed disrespect for all signs.

Local officials often face public pressure to install "Children At Play" signs. Although such signs have been posted widely in some communities, there is no evidence that they prevent injuries to pedestrians or decrease speed of vehicles.

"Children At Play" signs may give parents and children a false sense of security. Since nearly every residential block has children living on it, you would have to place a sign in each one. Blocks with no signs might imply to the driver that no children live there, and therefore it is all right to speed. Also, children may interpret these signs to mean it is acceptable to play in the street.

For these reasons federal and state sign standards discourage use of "Children At Play" signs. "Drive Carefully in School Zones" and "Slow Children" have also fallen out of use for some of the same reasons. However, you can and should post schools, pedestrian crossings, playgrounds and other recreational areas.
HOW TO LEASE EQUIPMENT

Tax-exempt lease-purchase is simply an alternate form of equipment financing. Its use is often triggered by these conditions:

- It is difficult to obtain needed funding of large capital outlays for equipment replacement because of political or fiscal constraints. Lease-purchase can convert large, lump-sum expenditures to multi-year, fixed operating costs which may be more acceptable to the taxing authority.

- Equipment tends to be retained beyond its useful life. By matching payment schedules to realistic life-cycles, lease-purchase can be a powerful tool in developing an equipment-replacement program. This can reduce life-cycle and overall operating and maintenance costs.

- Market conditions or legal restrictions prevent recovery of surplus equipment's fair market value. Through careful choice of residual values, some types of lease-purchase can eliminate or reduce the need for surplus disposal at below-market rates.

- Cash-flow considerations affect many decisions. Amortization of payments over several years lends itself to stable cash-flow and allows a much larger capital impact for each dollar spent. Furthermore, lease-purchase usually does not have a negative effect on government bond ratings.

- Because it has fewer legal restrictions, lease-purchase is often a less expensive financing source than bonds or capital-outlay notes.

Lease-purchase is known by several different names: finance lease, manufacturers lease, residual lease, governmental lease, municipal lease, municipal lease-purchase, and tax-exempt lease. Regardless of the name, it is a fairly complicated legal document which is three different things simultaneously:

- An operating lease or rental of equipment for a specified period time period.

- A conditional sales contract or installment financing agreement for purchase of equipment meeting qualifications of Internal Revenue Service relating to sale of equipment to tax-exempt organizations.

- Option to purchase the equipment at the end of the rental period at stated residual value.

Each of these characteristics is structured to uphold the tax-exempt status of the lease-purchase agreement. Tax-exempt status is integral to the agreement as it allows the lessor to offer finance rates considerably less than prime rate. Aside from low finance costs, these characteristics play an important role for the lessee. Because of the rental aspect of the agreement, lease-purchase is not considered long-term debt and does not generally affect bond ratings or financial position.

Lease-purchase differs from a standard lease in several ways:

- Tax-exempt status. The agreement is considered a conditional sale to a tax-exempt entity.

- The lessee is always a governmental entity with at least one of the following—taxing authority, police power, or power of eminent domain.

- Title to the equipment resides with the lessee. The lessor retains a security interest in the equipment as opposed to true leases where the lessor holds full title.

- To qualify for tax-exempt status, the lessee must certify that equipment is to be used for essential governmental purposes.

- The agreement is nullified if the legislative body does not appropriate sufficient funds annually for its continuance. This is always coupled with a nonsubstitution clause prohibiting the lessee from replacing equipment lost through nonappropriation. Purpose of these stipulations is to avoid the legal appearance of a multi-year agreement and to avoid procedural and legal requirements and costs associated with incurring long-term indebtedness.

While tax-exempt lease-purchase agreements are offered in many forms, they can be classified into three types—full-payout, closed-end, and open-end. Full-payout accounts for the vast majority of governmental lease-purchase arrangements. In its simplest form, it is a straightforward installment-financing agreement. Equity in the equipment is accrued over the term of the agreement since payments are structured so that residual value at term end is very small. With the final residual payment, the equipment becomes the unencumbered property of the lessee.

Flexibility of equipment choice, low finance rates, and ability to spread payments over several fiscal years have made this method very popular. However, it is not without drawbacks. Payments can be higher than in other options where equity is not built in equipment. Terms may exceed equipment's useful life, reinforcing a tendency to retain cost-prohibitive units. Few services are offered with these agreements. Finally, a lessee may be faced with acquisition and disposal problems.

Closed-end lease-purchase may be considered as rental of equipment's useful life. Typically, residual value is fixed when the agreement is made. Penalties are assessed for excessive mileage or poor condition (beyond normal wear and tear) that may affect residual market value. Residual value is essentially structured as a buy-out option which must be exercised to retain possession of equipment at lease end. This arrangement resembles a mortgage with a balloon payment because little or no equity in equipment is amassed unless the buy-out option is exercised.

This type of agreement is generally restricted to equipment with a good resale market such as
sedans, pickups, or medium-duty trucks. Although not often used, closed-end arrangements have distinct advantages including known fixed cost and lack of risks. By fixing residual value up-front, the lessor assumes risk of resale at lease end. This value will often exceed the surplus value obtainable by an agency, thus reducing life-cycle cost. In addition, payments are generally lower than for other lease-purchase arrangements because only part of capital cost is amortized over the lease term. In effect, only the portion of equipment life actually used is purchased and paid for. Equipment is usually returned to the lessor at lease end, helping foster a sound equipment-replacement program.

Open-end lease-purchase differs from closed-end primarily in the residual risk factor. In the open-end arrangement, the lessee is responsible for recovery of residual value at lease end. Generally, this means that lessees either buy the equipment at stated residual value or liquidate it. Lessees retain any profit over the residual value after liquidation; however, any loss must be made up by the lessee.

The main advantage of open-end lease-purchase is that it usually results in an even lower payment than for closed-end because the lessor is subject to a lower risk factor. However, some lessors set unrealistically high residual values to offer lower payments. Lessees then face large potential losses at lease end. Most public agencies are unwilling to accept the risk associated with residual liability but in some cases, the lower rates may outweigh potential liability.

All forms of lease-purchase have a great deal of flexibility. Terms, payments, rates, and other services are negotiable. As a general rule, terms should exceed one year and be limited to expected useful life of equipment. Finance rates will be affected by term length; longer terms generally carry higher interest rates. Lease-purchase is most feasible economically at a three- to five-year term. Terms should be at the lowest finance rate most closely matching equipment life-cycle.

Payments may be negotiated on a monthly, quarterly, or annual schedule and may be paid in advance or arrears. Finance rates can be fixed at time of contract or delivery, or may float throughout the term of the agreement. Although they may be offered at considerable discounts, floating rates carry significant risks. Fixed rates, while relatively higher, offer stable cost factors. An important factor in both types of rates is the index to which rates are fixed. Lessees should be sure than an index tracks closely with the real cost of tax-exempt financing sources.

Lease-purchase funds come from four places—banks and financial institutions, leasing companies, equipment manufacturers, and securities firms. Each has pluses and minuses. Banks and financial institutions have been considered the major source of lease-purchase funds. They can offer competitive rates, but they are generally conservative. Most consider only full pay-out lease-purchases and avoiding the more aggressive closed-end or open-end arrangements. These institutions typically offer few services, providing no help in equipment selection, acquisition, and disposal.

Leasing companies are geared to provide service. Not only can they supply financing, but they can help with selection, acquisition, disposal, engineering and specification services, repairs, maintenance management, fuel management, and other services. National companies have access to major financial markets and can offer very competitive rates. Some firms have influence with equipment manufacturers, enabling them to obtain discounts and incentives.

Manufacturers themselves should not be overlooked as sources of lease-purchase financing. While their finance rates may not be as low as those from other sources, residual values tend to be higher which may offset the rate difference. Major drawback of this source is linking of lease-purchase to the manufacturer's make of equipment.

Securities firms are a relatively new source of financing. These firms often have funding sources in major tax-exempt markets. Most of these companies have experienced legal counsel and have established good working relationships with governments. Like banks and financial institutions, their major flaw is their concentration on financing lease-purchases when other services may be required.

Selecting a lease-purchase program can be accomplished in many different ways. Approaches vary from the piecemeal concept of competitively bidding each item or group of equipment with separate bidding for financing to comprehensive multi-year packages combining equipment acquisition, financing, disposal, and other services. Individual bids are most appropriate when single items or small dollar values are involved. Comprehensive requests for proposals can be useful when lessees wish to acquire and finance a large group of different items. By combining all equipment into one package, a better finance rate can be obtained. In-house administration is simplified as only one contract is required. Also, specific makes of equipment can be required. Requests for proposals allow wide ranges of options to be presented, but evaluation standards must be constructed carefully to ensure that differing proposals are evaluated objectively.

MAINTENANCE TIPS

GUARD RAIL REPAIR

Guard rail repair is required when the guard rail is damaged by accident, vandalism, or normal deterioration. Damaged guard rail, with bent or broken sections, prevents the rail from providing its intended purpose and can lead to additional rail deterioration.

Guard rail is normally damaged during vehicular accidents. The damage can be found at any location where guard rail exists.

Guard rail is placed in locations to decrease accident hazards, and any section that does not perform this function constitutes a hazard to motorists. Guard rail that is bent or broken is unsightly and may further deteriorate, resulting in increased maintenance costs.

Crew required for guard rail repair:

- Equipment operator 1
- Laborers 3
- Flagmen 2

Equipment required:

- Stake truck 1
- Post driver or auger 1

Daily production per crew: 60-100 linear feet

Repair procedure:

1. Place warning signs and other safety devices for motorists' and crew protection.
2. Remove damaged parts and straighten when possible.
3. Realign loose posts and recompact.
4. Install new posts as required.
5. Install new rail. All repairs should be made to latest standards. Guard rail ends should turn away from roadway and/or taper down to a buried end. Bridge approach guard rail should be affixed to the bridge railing with no gaps. All guard rails should be offset from rigid posts by wooden 6x6 blocks.

SIGN REPAIR OR REPLACEMENT

Damaged signs are a severe hazard to motorists. They prevent adequate traffic control and do not provide motorists with advisory warning of roadway alignment.

Traffic signs may be damaged by accident, vandalism, or normal deterioration. The most common cause is vandalism, and signs damaged in this way are normally located on roads that have light traffic.

Sign repair or replacement is required when signs are damaged to an extent that they are no longer visible or legible to the motorist.

Crew required for sign replacement or repair:

- Laborers 2

Equipment required:

- Stake truck 1
- Post driver 1
- Hand tools

Material required:

- Signs
- Sign posts
- Paint

Daily production per crew: 7-10 signs

Repair procedures:

1. Place warning signs and safety devices for motorists' and crew protection.
2. Note signs requiring replacement.
3. Replace signs which are difficult to read.
4. Straighten or replace bent posts. Paint as required.
5. Remove warning signs and safety devices.
Who pays for local roads in the United States? In the wake of declining federal funds, municipal officials are turning to their own residents to finance nearly 3 million miles of city streets, county highways, and township roads. According to the Federal Highway Administration, local taxes and user fees paid for nearly two-thirds of all improvements in 1986. State contributions amounted to 18%, and bond revenue provided another 13%. The federal share is only 4%, down from 8% in 1979.

As public agencies struggle to balance their budgets, street maintenance often is one of the first programs targeted for cutback. In the face of competing demands and a limited budget, how can transportation officials convince their communities that roads are critical? The issue was on the agenda of the 1987 National Symposium on Local Roads, where representatives of 16 state and local agencies reported on their successes. The meeting was sponsored by America Runs on Local Roads, a coalition of organizations ranging from APWA to the National Association of Mail Carriers.

Here's a brief sample of some approaches reported at the symposium:

**Grassroots involvement:** The car population of Anchorage, Alaska, has doubled since 1980, triggering a flood of complaints from irate citizens about speeding and pass-through traffic in residential areas. But public works officials discovered their strongest allies after starting a neighborhood traffic management program three years ago.

Under the program, the city's traffic engineers actively seek out community councils in areas with obvious traffic problems. The first step in the three-month targeted process is a community meeting, where residents express their concerns and propose solutions. After conducting a traffic study, city staff present a detailed report and several options at a second public meeting. Neighborhood representatives are asked to select the approach that best suits their needs.

"All of the recommendations emerging from the community councils have made sense from an engineering viewpoint," says municipal traffic engineer Frank Tecca. "There's a general tendency among traffic engineers to regard citizens' groups as being too emotional. But if you present the facts clearly, most people quickly grasp the basic principles. We spent a lot of money on graphics and map overlays for the neighborhood meetings."

**Political courage:** Faced with 1,500 miles of gravel roads and not enough money, the Board of Commissioners in Spokane, Washington, abandoned the county pavement program in 1980. The county successfully encouraged the use of special assessment districts, which now pay for most road paving projects. "There were a lot of objections initially from groups who felt that they had been 'promised' a paved road," recalls Verril Smale of the county engineering office. "But the policy has paid off. Special assessments have paid for nearly $20 million in improvements.

**Innovative financing:** It's not a typical local road, but the eastern half of a proposed beltway around Denver is being financed through a unique combination of bond revenue, local taxes, and impact fees. While the highway was proposed as early as 1958, it was never built. By the mid-1970s, traffic congestion threatened to overwhelm the eastern metropolitan region.

After more than a decade of public debate, the City of Aurora and three surrounding counties formed an authority to fund, build, and operate the 50-mile highway. The intergovernmental agreement also features substantial involvement by the private sector. Area developers will be required to pay impact fees and dedicate nearly two-thirds of the right-of-way. Maintenance and bond payments will be funded by tolls, a motor vehicle surcharge, and an areawide sales tax. Construction is expected to start later this year after everyone signs off the financing plan.

The Colorado approach may become a model, predicts John Arnold, executive director of the E-470 Authority. "We think that the financing mechanism may be the fairest ever devised to fund a major highway project."

From Transportation, APWA, 1st Qtr., 1988.
IMPROVED CENTERLINES MEAN SAFETY

Georgia's Department of Transportation improved safety by establishing a centralized office to manage centerline marking for the entire state. Jerry Gossett, Chief of Maintenance Activities, heads the 150-member unit, which also maintains some statewide pavement rehabilitation operations. A sign shop which manufacturers official state highway signs is also part of the operation.

Two seven-man crews in the centerline group install pavement markers and two crews place striping for more than 85% of the state's needs. Remaining work is contracted.

Longevity of retro-reflectivity is a critical factor in marking, Gossett says. About two years ago, a prototype of a new marker was brought to Georgia for evaluation.

The markers' initial retro-reflectivity readings were 4.5 to 5.5 for 0.2-degrees observation angle, 0-degree entrance angle. These 948 Sun Country Markers were first placed on I-75, using bituminous adhesive.

After a year, a few markers were taken up and tested for reflectivity. Readings were about 1.5, compared to 0.1 for conventional plastic markers that had been in use for a year.

After a year and a half, the markers are still "looking good," Gossett says.

Because of test results, Georgia plans to use the markers in metropolitan areas to aid motorists in wet night conditions, and to help clarify lane delineation. In the first phase of this work, about 150,000 markers were installed on the highway system.

The markers rise 0.5 in. above the pavement, above any water accumulation during rain, providing reflectivity—even on a wet night.


A DICTIONARY ON PAVEMENT MAINTENANCE PROBLEMS

It is essential to understand the cause of a pavement defect before an attempt is made to remedy it. Like any other professional field, pavement maintenance has its own terminology. The following explanations of common maintenance problems should help in selecting the appropriate treatment of the defect, thereby reducing the chance of the problem reoccurring.

The best known of the pavement imperfections, "pot holes," are bowl-shaped holes in the pavement, often the result of progressive deterioration of other defects such as "alligator cracking" (to be described later). Potholes are usually caused by a combination of weaknesses in the pavement, such as too little asphalt, poor drainage, and traffic, thus requiring deep pavement patching.

"Rutting" is the longitudinal depressions that form in the wheel paths and have a minimum length of about 20 feet. Ruts can be caused by lateral traffic movement or by displacement in the asphalt surface layer. Ruts should be filled with hot plant-mixed materials to restore a proper cross section, then covered with a thin overlay.

Consisting of alternate, closely spaced valleys and crests, "corrugations" occur at regular intervals and are caused by a lack of stability in the asphalt layers. Before resurfacing can take place, these ripples need to be repaired. In the worst scenario, shallow corrugations can be removed with a pavement planing machine, better known as a "heater-planer," followed by a seal coat or overlay.

Usually requiring a seal coat, "raveling" is the progressive disintegration from the surface downward or the edges inward from the dislodging of particles. This defect is usually caused by improper compaction during construction, construction during wet or cold weather, too little asphalt in the mix, or overheating of the asphalt mix.

When asphalt layers are unstable, traffic can cause a lateral displacement of the paving material that results in a bulging of the surface, known as "shoving." Maintenance of this flaw requires removing the affected area, followed by deep patching.

"Faulting" is a vertical drop of the pavement slabs adjacent to a joint or a crack. In the case of longitudinal joint faulting, settlement is generally confined to the lane receiving the heavier traffic. When transverse joint or crack faulting is present, the impact from axle loads generally causes settlement of the downstream slab.

"Deficient drainage" can be a surface and a subsurface problem. Proper surface drainage efficiently removes runoff from the pavement and the nearby ground. Standing water on the pavement or in the side ditches indicates surface drainage deficiency. Proper subsurface drainage keeps groundwater away from the pavement surface. Two indicators of deficient subsurface drainage are, in the absence of precipitation, water in a side ditch or alligator cracking with moisture in the cracks.

"Pumping" is the ejection of water and/or subbase material along the pavement joints, cracks, and edges caused by the force of heavy axle loads on the pavement slab. Pumping can be detected by stains on the pavement surface adjacent to the joint, crack, or edge, and/or by the deposit of fine material adjacent to the pavement.

Caused by naturally smooth uncrushed gravel and crushed rock that wears down quickly under
traffic, "polished aggregate" refers to the aggregates in the pavement surface that have been polished smooth. To combat this problem, cover the surface with a skid-resistant treatment.

"Excess asphalt" (or "bleeding") is the free asphalt on the pavement's surface caused by too much asphalt in one area. In many cases, bleeding can be corrected by repeated applications of hot sand or hot rock screenings to blot up the excess asphalt. Sometimes, when bleeding is light, a plant-mixed surface treatment or an aggregate seal coat, using absorptive aggregate, is the only treatment required. In rare instances of heavily over-asphalted surfaces, the surfaces should be completely removed.

"Shrinkage cracks" are interconnected cracks forming a series of large polygons, usually have sharp angles at the corners. These defects are caused by volume change in the asphalt mix or in the base or subgrade. To correct this problem, fill the cracks with asphalt emulsion slurry followed by a surface treatment, or a slurry seal over the entire surface.

"Transverse cracks" occur at approximately right angles to the pavement centerline. This frequently is caused by movement in the pavement beneath the asphalt layer (reflection cracking). Stress induced by low-temperature contraction of the pavement also causes this type of cracking. Transverse cracks should be filled with asphalt emulsion slurry, followed by a seal coat or overlay over the entire surface.

"Longitudinal cracks" follow a course approximately parallel to the centerline. Although usually the result of a weak joint between paving lanes, these cracks can also be caused by earth movements, particularly on embankments. Two closely spaced longitudinal cracks in a wheel path usually indicate bending stress induced by rutting. Longitudinal cracks can also occur from movement in the pavement beneath the asphalt layer (reflection cracking).

"Alligator cracks" are interconnected cracks forming a series of small polygons, a pattern resembling an alligator's skin. Requiring deep patching, these cracks are caused by excessive deflection of the surface over unstable subgrade or lower courses of the pavement. A saturated granular base or subgrade is usually the culprit creating the unstable support.

Although not complete, the preceding terms and explanations should be helpful in understanding road surface difficulties.

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holds back an amount of mixing water equal to the amount added to the holdover concrete when the stabilizer was added. This keeps the water-cement ratio and strength at the desired level. After several more minutes of mixing, the concrete is ready for dispatching.

**WASHOUT WATER TREATMENT**

Using the stabilizer for washout water treatment saves up to 90% of the water normally used. Before switching to the chemical system for washout, Coast Rock used about 300 gallons of water to clean each truck drum. Disposing of this water without polluting was a problem. Now no water is wasted.

To wash out an 8- or 10-yard truck, the driver adds 30 to 60 gallons of water and 32 to 64 ounces of stabilizer to the drum, mixing for several minutes. When adding the water, he hoses down the exposed fin surfaces and reverses the drum until the solution of stabilizer and washwater nearly discharges. This cleans the backside of the fins. The next day, stabilized washout water left in the truck is used as part of the mix water.

When they first started trying the system for washout water treatment, Coast Rock's Jim Soares and Regis Brannigan weren't sure how effective it would be. Initially they had drivers pull truck hatches every couple of days to make sure there wasn't a concrete buildup. The inspection interval, though, was gradually lengthened until now no further inspections are made.

The standard dose of stabilizer keeps cement in the washout water from hardening for 24 hours. Increasing the stabilizer dosage rate to 64 to 96 ounces per truck stabilizes washout water over a weekend.

**STABILIZATION IMPROVES STRENGTH**

Batches containing holdover concrete show a strength improvement over batches of normal concrete. Tests at more than 15 sites where the system has been used on a trial basis show strength gains ranging from 5% to 20%. The higher the percentage of stabilized concrete, the higher the strength. Concrete held over a weekend instead of just overnight gains even more strength.

Strength tests and other studies are made by a two-person team assigned by the chemical system manufacturer to each plant where the system is used. The team's first task is conducting time-of-set tests on concrete made with local materials. After establishing typical setting times at different temperatures, the team determines needed stabilizer and activator dosage rates for differing conditions.

The amount of stabilizer needed to hold concrete for later use depends on several factors:

- Amount of concrete returned
- Amount of cementitious material (including admixtures)
- Age of the concrete (hours since the initial mix water was added)
- Air and concrete temperature
- Duration of desired holding period

Needed dosage increases with cement content, age of the concrete, and length of holding period. It also increases if air temperature is greater than about 80°F. Cost of the chemicals usually makes holding concrete too expensive for concrete older than a couple of hours. Coast Rock uses older concrete to make precast concrete blocks used for erosion control.

**GOOD RECORD KEEPING ESSENTIAL**

The batch man must keep track of which trucks hold stabilized concrete and how much activator is needed for each truck. He calculates activator dosage when the stabilizer is added. This information is recorded in a log that shows for each truck:

- Weight and volume of returned concrete
- Original mix design and aggregate size
- Admixtures present in the initial concrete
- Cement content of the original concrete
- Time at which the original concrete was batched
- Temperature and slump of returned concrete
- Water added to returned concrete before adding stabilizer
- Ounces of stabilizer and time it was added
- Ounces of activator and time it was added
- Yards batched after activation
- Slump after activation and loading

Continued on page 12
WORKSHOPS

Soil Compaction Seminar
How to Design, Construct and Test Earth Fills
October 20, 1988
Atlanta, Georgia

This seminar is a comprehensive, one-day seminar for contractors, engineers, architects, government officials, and technicians seriously interested in saving money by understanding soils. Participants will learn the correct techniques involved in designing, preparing, and testing soils for earthwork projects.

The course is practical, hands-on, and oriented to problem solving. Participants follow along, working out solutions in a specially-written 80-page reference workbook.

The registration fee for this seminar is $149 per attendee if you register at least one week prior to the seminar. (Additional attendees from same firm, call for price information.) To register, or to obtain further details, contact BENDER AND ASSOCIATES at 509/534-1426.

RIGHT-OF-WAY ACQUISITION
DECENT, SAFE, AND SANITARY HOUSING & BUSINESS MOVES

The Technology Transfer Center is sponsoring a one-day workshop which will cover topics on Right-of-Way Acquisition: Decent, Safe, and Sanitary Housing and Business Moves. The courses are designed for the new right-of-way agent and for the experienced employee whose background has been limited to other right-of-way disciplines.

The first course will provide information on criteria for decent, safe, and sanitary housing. Participants will examine Federal regulations along with State/Local building, plumbing, electrical, housing, and occupancy codes to see how these codes conform to Federal regulations to provide decent, safe and sanitary dwellings as required by Federal Law.

The purpose of the second course is to encourage and promote the use of sound business practices in administering the moves of businesses, farms, and non-profit organizations. First, we will review the objectives of the Uniform Relocation Act with regard to the range of benefits and services available, to assure that the displacee is treated fairly and equitably. Secondly, we will review the monetary payments for moving businesses and how to determine actual reasonable cost and documentation requirements.

Please register no later than one week prior to the date of the presentation that you wish to attend. Contact the Technology Transfer Center (1-800-282-1275 or 404/894-2360) to register or if you have further questions.

ACKNOWLEDGEMENT

The Technology Transfer (T2) Program is a nationwide effort financed jointly by the Federal Highway Administration and Individual State Departments of Transportation. Its purpose is to translate into understandable terms the latest state-of-the-art technologies in the areas of roads, bridges, and public transportation, to local and county highway and transportation personnel.

The T2 Center at Georgia Tech is sponsored by the Georgia Department of Transportation and provides information and counsel to more than 500 municipalities and counties in our state. This newsletter is designed to keep you informed about new publications, new techniques, and new training opportunities that may be helpful to you and your community. Individuals wishing to receive future copies of this newsletter at no cost may send their requests to:

M. John Moskaluk
Technology Transfer Center
School of Civil Engineering
Georgia Tech
Atlanta, Georgia 30332
Keeping track of trucks holding stabilized concrete isn't hard because the hopper is covered with a tarp. But it's also important to know how much activator is needed for each of the trucks. One man must be responsible for the needed record-keeping.

It's important to accurately determine the volume of returned concrete. Originally drivers were asked to estimate how much concrete was left in the truck. Estimates were often imprecise and this caused problems in choosing the right dosage of stabilizer. Now trucks are weighted to determine how much concrete is left.

Truck drivers have to be trained to properly add stabilizer and activator, spraying it directly on the concrete and not on the fins. They also need to use the right procedure for stabilizing washwater and making sure fins are rinsed by reversing the drum to back up washwater.

COST OF USING THE CHEMICAL SYSTEM

Coast Rock Concrete produces about 70,000 cubic yards of concrete annually. Typically about 2 to 3 yards of concrete are returned daily. Their records show that receipts from the sale of stabilized and reactivated concrete about balance costs of the chemicals used for both stabilization and washwater treatment. There's an upfront cost of about $5,000 for dispensing equipment, much less than the cost of reclaiming equipment and a slurry pit.

Each producer's experience will determine costs of using the system. In hot climates higher needed dosage rates drive up costs. The moderate climate for Coast Rock's plant, however, allowed reducing recommended dosage rates and thus recovering nearly all of the system costs.

From Concrete Construction, May 1988.

M. JOHN MOSKALUK
TECHNOLOGY TRANSFER
SCHOOL OF CIVIL ENGINEERING
GEORGIA INSTITUTE OF TECHNOLOGY
ATLANTA, GEORGIA 30332
HOW TO DECIDE WHEN TO PAVE A GRAVEL ROAD

Two-thirds of the roadway system in the United States is unpaved or lightly surfaced. Most local roads are not designed or engineered like state or interstate highways. As local roads were improved over the years, little improvement to the foundation was made before the road was sealed or paved.

Many of these roads now have continual maintenance problems because of inadequate sub-base, poor alignment and drainage problems. Also, many roads are now experiencing increasing weights and volumes of traffic.

Deciding to pave is a matter of tradeoffs. Paving helps to seal the road surface, protecting the base of subgrade. It is less dusty, gives a smoother driving surface and can accommodate many types of vehicles. Gravel roads have lower construction costs, and often lower maintenance costs. They are easier to maintain and require less equipment. Potholes can be patched more effectively.

"Should we pave this gravel road?" There are 10 parts to this question, and all need to be considered before a decision is made.

1) When the Town or County is Committed to Excellence.

This commitment means long-range planning, using good management techniques, and taking advantage of available training. It means taking the time to do things right the first time and constructing projects to last. This helps to make better decisions, saves money in the long run, and results in a better overall road system.

2) After Developing a Road Management System.

This system is a common-sense approach to scheduling and budgeting for the road maintenance work. It consists of surveying the mileage and condition of the roads, establishing short-term and long-term maintenance goals, and prioritizing road projects according to budget constraints.

3) When Traffic Demands It.

Average daily traffic volumes, types of traffic and the functional importance of the road all need to be considered when faced with the question of whether or not to pave. Gravel roads with traffic volumes over 70-100 vehicles per day become candidates for stabilization, dust repressants and surfacing.

4) After Standards Have Been Adopted.

Design and construction standards don't have to be complex; just outline things such as right-of-way width, traveled way width, depth of base, drainage considerations, types of surfacing, etc. Maintenance standards include how often new gravel should be applied to a gravel road, how many times a year roads are to be graded, how often and where calcium chloride or other road stabilizers should be applied, what the plan is for checking road signs, cleaning ditches, striping, etc.

5) After Considering Safety and Design.

Roads must be designed to provide safe travel for the expected volume at the design speed. To do this, a number of physical features must be considered: sight distance, alignment, lane width, design speed, surface friction and superelevation. It makes no sense to pave a gravel road which is poorly designed and hazardous.

6) After the Base and Drainage are Improved.

Build up the road base and improve drainage before paving. If the foundation fails, the pavement fails. If water is not drained away from the road, the pavement fails.

7) After Determining the Costs of Road Preparation.

Road preparation costs are the costs of construction before paving actually takes place. Costs will vary

(continued on page 5)
THE "TOP TEN HITS": MOST COMMON DRIVING ERRORS

Human error accounts for a definite ninety-three percent of all traffic accidents. The National Safety Council has developed a pamphlet with the ten most common driving errors. Below is the list, in order of frequency:

- Improper lookout (for example, pulling into a street from an intersecting street or driveway without looking carefully for oncoming traffic).
- Pulling out to pass without checking for traffic in the passing lane.
- Pulling out of a parking space without looking back for oncoming cars.
- Excessive speed.
- Inattention.
- Improper evasive action (no attempt to steer around an impending crash or an attempt to steer that was unsuccessful because brakes were slammed and the front wheels locked).
- Internal distraction.
- Inadequate defensive driving techniques.
- Unjustified assumption (for example, when turning across two lanes of oncoming traffic, assuming there is no traffic coming in one lane when a driver makes way for you in the other, or assuming another driver will stop or yield even though he doesn't have a sign).
- Improper maneuvering (driving the wrong way on a one way street or turning from the wrong lane) and over-compensation (accelerating or braking too fast or turning too quickly).

(From "Kansas TRANS Reporter," July 1988)

NEWS BRIEFS

Robert E. Farris was unanimously confirmed on June 6, 1988 as the new Federal Highway Administrator. Farris has been acting administrator since the retirement of Ray Barnhart in December 1987.

Lowell B. Jackson, formerly executive director of the Colorado DOT, has been appointed as deputy administrator of FHWA.

U.S. traffic deaths increased from 48,300 in 1986 to 48,800 in 1987 according to the National Safety Council. Although complete data is not yet available, the Council says that raising the speed limit to 65 mph on rural interstate highways may have had an impact on the 1987 traffic-death toll.

A 65 year old person driving at night needs 4 times the light for good vision as he or she needed at age 39. Night vision requirements need careful consideration when designing highway markings, signage, and other safety features. The 65 and over age group is growing by half a million persons each year; and the fastest growing age group in the country is 75 and over. One of the best night driving aids for all drivers and especially for older drivers is wider edgelines. Increasing edgelines from 4 inches to 8 inches received praise from drivers taking part in a study conducted for the American Association of Retired Persons. The volunteers also gave high marks to reflectorized post delineators.

Some of the most common guardrail transitions have failed crash tests according to FHWA Technical Advisory T 5040.26. The two common elements of the failed systems are: 1) vehicles snagging on a vertical concrete face of the toe of a concrete safety shape barrier, and 2) inadequate guardrail stiffening allowing excessive guardrail deflection, resulting in snagging or poor redirection of vehicle.

The advisory states that "Almost all existing W-beam guardrail systems that connect directly to a bridge rail without blockouts or a rubrail near the bridge connection should be considered unsatisfactory..." Suggestions for stiffening transitions are also contained in the advisory.

Federal Highway Administration has released several technical summaries. Topics include traffic-conflict techniques for safety analysis, speed control through work zones, evaluation of equipment for measuring voids under pavement, traffic forecasting for pavement design, driver response to selected lane and road-closure barricades, minimizing signal maintenance, quantifying urban freeway congestion, and analysis of drying methods for calcium-magnesium acetate solution. To learn more, contact William Zaccagnino at 703/285-2104.

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AUTOMOBILE ACCIDENT STATISTICS
GEORGIA, 1987

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WORKSHOP!!!

RIGHT-OF-WAY ACQUISITION:

BUSINESS MOVES and DECENT, SAFE, AND SANITARY HOUSING

The Technology Transfer Center is sponsoring a one-day workshop which will cover two topics on Right-of-Way Acquisition: Business Moves and Decent, Safe, and Sanitary Housing. The courses are designed for the new right-of-way agent and for the experienced employee whose background has been limited to other right-of-way disciplines.

The purpose of the first course is to encourage and promote the use of sound business practices in administering the moves of businesses, farms, and non-profit organizations. The second course will provide information on criteria for decent, safe, and sanitary housing.

The registration fee for the one-day workshop is $50 per person. The fee should be made payable to the Department of Transportation and presented on the day of the workshop.

The workshop will be presented in each of the seven DOT districts in the auditorium of the district office. The dates and locations are as follows:

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* These dates differ from those given in the summer edition of Tech Trans. Please note that these are the correct dates.

Please register no later than one week prior to the date of the presentation that you wish to attend.

Contact the Technology Transfer Center (1-800-282-1275 or 404/894-2360) to register or if you have further questions.

NEW PUBLICATION AVAILABLE:

RETROREFLECTIVITY OF ROADWAY SIGNS FOR ADEQUATE VISIBILITY

FHWA has just published an excellent guide on reflectivity and visibility of roadway signs. The document titled "Retroreflectivity of Roadway Signs for Adequate Visibility: A Guide," provides an excellent primer on all aspects of highway signs. It is a good reference document that should be in the hands of all manufacturers, installers, and users of highway signs.

The manual interprets and explains the specifications and test procedures dealing with retroreflective sheeting and related matters and provides good guidance for the selection, fabrication, and maintenance of signs.

FHWA has a limited number of copies and anyone wishing to receive one may contact Phil Russell at FHWA's Office of Traffic Operations, phone (202) 366-0411. The document is also available from the National Technical Information Service, Springfield, Virginia 22161.
DEEP PATCHING WITH PREMIX

Asphalt cracks occur for different reasons and in different forms. The maintenance of each crack depends on the crack type and cause of occurrence. Deep patching with premix is used to repair alligator and slippage cracks and severe potholes.

Alligator cracks are numerous and short in length, forming small blocks which resemble the skin of an alligator. They are caused by a relatively stiff pavement which is excessively deflected. The most common cause of this failure is a spongy subgrade of unstable base material resulting from saturation of the base. Initially, alligator cracking is not critical, but it will deteriorate rapidly under traffic into other types of deficiencies such as potholes.

Slippage cracks are crescent (half-moon) cracks in the direction of traffic flow with the two ends pointing away from the direction of flow. They are caused by the asphalt concrete surfacing sliding on the underlying surface due to the lack of a tack coat. They may also occur when the pavement is deflected excessively due to the braking of heavy vehicles. For failures resulting from lack of bond, the correct repair method is spot patching with premix. When failure is caused by excessive deflection, deep patching with premix is a good solution.

Crew required:
- Equipment operators 2
- Truck drivers 2
- Laborer 1
- Flagmen 2

Equipment required:
- Dump trucks 2
- Portable roller 1
- Motor grader 1
- Asphalt kettle 1
- Gradall or front end loader 1
- Concrete saw or air compressor 1

Material required:
- Hot premix asphalt concrete
- Liquid asphalt tack coat
- Base material (if required)
- Underdrain pipe (if required)

Repair procedure:
1. Place signs and other safety devices.
2. Break out and remove old pavement. Cut vertical edges 6 inches outside the distressed area on all sides. Make cuts square with roadway centerline.
3. Install underdrains if required.
4. Recompact base material and replace unsuitable material.
5. Apply light even tack coat of heated asphalt to the vertical sides of the area.
6. Place hot premix into area using a motor grader or by hand and spread material in layers not exceeding 3 inches. Roll each layer before applying another layer.
7. Compact the surface with a portable roller.
8. Check the surfaces with a straight edge to assure it is level and flush with the adjacent surface.
9. Clean up area and remove signs.

SPOT PATCHING WITH PREMIX

Spot patching with premix is commonly used to repair potholes which are caused by poor design or construction practices such as too thin an asphalt surface, poor drainage or inadequate base. During bad weather, temporary repairs can be made to eliminate the potholes. This involves cleaning out the hole and filling it with premixed patching materials. However, as soon as possible permanent repairs should be made by spot patching with premix.

Crew required:
- Truck driver 1
- Laborers 2
- Flagmen 2

Equipment required:
- Dump truck 1
- Portable roller or vibrating tamper 1
- Asphalt kettle 1
- Concrete saw or air compressor 1

Material required:
- Hot asphalt concrete
- Liquid asphalt tack coat

(continued on page 5)
What you have all been waiting for is finally here—on-site workshops! The Technology Transfer Center is up and running with three new one-half day presentations:

"Operator Daily Maintenance of Equipment"
"Repair and Resurfacing Pavements"
"Maintenance and Repair of Bridges and Ditches."

The purpose of these workshops is to make the expertise and materials available from the Technology Transfer Center more accessible to you and your crew. More of your personnel can have the benefit of the training provided by the Center, since the man-hours lost in travelling to workshop locations will be eliminated.

You can request for any or all of the workshops to be presented in your shop or office. Video presentations will be accompanied by manuals, which will provide basic, step-by-step instructions. The presentations average approximately three hours in length, so your crew would be off the job for only one-half day. The acquisition of invaluable training will more than compensate for their time.

Please contact the Technology Transfer Center if you are interested in having one or more of the workshops presented in your area.

Also, please remember the on-going services offered by the Technology Transfer Center. Traffic data collection equipment is available for use by your agency at no charge to you. The equipment has been serviced and is waiting to be used.

We continue to maintain a library of video tapes and technical publications, which we will be more than happy to let you borrow. Just give us a call.

After Comparing Pavement Costs, Pave/Not Pave Decision.
The next financial consideration is to compare maintenance costs of a paved road to maintenance costs of a gravel road. To make a realistic comparison, we must estimate the years of pavement life and the actual cost of paving, along with the life cycle costs such as chip sealing every five to seven years. At this point, a town or county can begin to compare costs between the two types of roads. It should be noted that some local governments have had to turn their asphalt roads back into gravel roads due to high maintenance costs.

9) After Comparing User Costs.
There is a significant difference in the cost to the user between driving on a gravel surface and on a paved surface. Therefore, user costs need to be considered in the pave/not pave decision. Vehicles cost more to operate on a gravel surface. The roughness of the surface adds to fuel cost, tire wear, and maintenance and repair expenses. Dust causes extra engine wear, oil consumption and maintenance costs.

10) After Weighing Public Opinion.
Public opinion needs to be considered, but only after the public has been made aware of the other important factors concerning the decision to pave.

Another approach to consider is "stage construction design." A design is prepared for the completed road, from base and drainage to completed paving. The construction is then spread out over three to five years. This not only makes the cost more manageable, but also helps show weak spots in the base before paving is done.

Carefully considering these 10 points will help to assure towns and counties that they are making the right decision about paving a gravel road. (Reprinted from RTAP Quarterly Newsletter, Montana State Univ., December 1987)

Repair procedure:

1. Place signs and other safety control devices.
2. Cut a neat vertical edge with saw or jackhammer, 4-6 inches outside the distressed area on all sides. Make cuts square with roadway dimensions.
3. Clean hole of debris and as much water as possible. Heat with torch if necessary.
4. Apply tack coat to the vertical sides and bottom of the hole. The heated asphalt should be light and uniform.
5. Place hot asphalt concrete premix into the hole to be patched. Premix should be placed in layers not exceeding 3 inches and compacted before applying another layer.
6. Roll the surface with a portable roller or a vibrating tamper.
7. Check the surface with a straight edge to assure it is level and flush with the adjacent surface.
8. Clean up area and remove signs.
WARNING SIGNS SHOULD KEEP THEIR DISTANCE

by R.L. Carstens, P.E., Consulting Engineer

Each of the last three editions of the Manual of Uniform Traffic Control Devices (MUTCD) has included a statement to the effect that, in rural areas, warning signs should normally be placed about 750 feet in advance of hazardous conditions. On high-speed roads, particularly freeways, advance warning distances should be at least 1,500 feet, whereas on low-speed roads, as in urban areas, the advance warning distance need only be 250 feet.

This has properly been interpreted to permit the placement of warning signs at varying distances in advance of potential hazards depending on the road profile and other factors affecting the sign's visibility. However, when accidents lead to lawsuits, plaintiff's lawyers and the "experts" have tended to suggest that the 750-foot and 250-foot distances are precise and inviolate.

Some examples of cases in which the placement of a warning sign became a matter of issue in a lawsuit are: a railroad advance warning sign at 511 feet on a paved road, a T-intersection sign at 605 feet on a county gravel road, a reverse-turn sign at 350 feet on a paved county road in a suburban location, a curve sign at 233 feet on an oiled county road, a stop-ahead sign at 1,302 feet on a state primary highway, and a stop-ahead sign at 1,676 feet from the intersection on a paved county road.

In the latter case, the location of the stop-ahead sign probably was given considerable weight by a jury, so that it returned a very large judgement against the county for their negligence. The primary highway sign at 1,302 feet led a plaintiff's "expert" to state, "If motorists are given advance warning too far ahead, then it is difficult for them as motorists to retain that information and to relate it to the hazard that is being warned about."

However, in a recent change to the MUTCD, minimum warning sign placement distances are specified and vary with the posted or the 85th percentile speed. Although it is too early to judge the result of this change, it is certain that those responsible for the placement of warning signs must be more attentive to the minimum distances prescribed for the placement of warning signs and also to the maximum distance where the motorist will retain the sign's message.

(From Iowa Technology News, Iowa State University)

FROM LITTLE WEEDS GROW LARGE LAWSUITS

A single vehicle accident on a county gravel road in July 1979 resulted in fatal injuries to a passenger in the small pickup truck involved. The vehicle overturned in the roadway when the driver swerved to avoid an automobile entering the roadway from a farm driveway.

The entering vehicle reportedly had stopped with its front near the edge of the traveled portion of the roadway. This position was necessary because of sight restrictions resulting from the presence in the right-of-way of large trees in the farmstead's windbreak. In the resulting lawsuit, the county contributed a five-figure amount to the settlement, which was reached without a trial.

A two-vehicle collision in July 1981 occurred when a westbound small pickup truck failed to yield to a stop sign and was struck broadside by a southbound vehicle. The passenger in the pickup was injured and initiated a lawsuit against the county involved. Witnesses for both sides agreed that weeds and grasses growing in the right-of-way in the northeast quadrant obscured the view of a westbound driver unless a vehicle was stopped so that it encroached slightly on the traveled portion of the north-south gravel road. This case settled without a trial, and the county contributed a five-figure amount to the award.

A collision occurred on an oiled county road in August 1983, when a southbound automobile collided with a northbound moped. The 14-year old moped operator was fatally injured. His parents sued the county involved, alleging that sight distance was insufficient on the curve where the accident occurred due to weeds and brush in the right-of-way. After the plaintiffs declined to accept a pretrial offer of settlement in five figures, a jury trial found that the county had not been negligent.

In each of these cases, the common factor was the presence in the highway right-of-way of vegetative growth that was alleged to have contributed to the accident. Most counties have adopted policies that substantially limit spraying, mowing, or cutting to control weeds and brush. Although these policies have been adopted in the interest of economy, they have received widespread support for their scenic enhancement and wildlife preservation. While these environmental objectives are laudable, counties should be alert to the possible need for spot control of vegetation at locations where the motoring public's safety would otherwise be seriously compromised.

(Reprinted from: Rural Technical Assistance News, Maine Department of Transportation/University of Maine, Spring 1987)
THICKER PAVEMENT HELPS REDUCE CHANCE OF POTHOLES

Through collaboration with other pavement engineers, an interesting and significant performance observation came up. Once a pavement is 3 1/2 to 4 in. thick it cannot pothole (in the strict classical sense of the bowl shaped pothole that loses pavement and is deepened and enlarged by traffic as the granular base is eroded).

In accordance with the information and test results reported by Martin Ekse, Volume 29, AAPT, 1960; W. Phang, Volume 50, AAPT, 1981; and WASHO, Test Road Report, Part 2, Test Data, Analysis, and Findings, nine aspects of the 4 in. pavement design exist:

1. Four in. minimum pavement has more strength than AASHTO or other criteria indicated by straight-line coefficient usage.

2. Distress cracking in a pavement expands and multiplies rapidly when pavements are thinner. The cracking breaks the pavement into many small pieces. However, there is less fragmentation with 4 inch-plus pavements. Also, rutting and waviness which reflect base material stress and freeze/thaw effects are virtually eliminated on 4 inch-plus pavements.

3. There is often a great deal of strain with a 2 1/2 inch design due to construction traffic in site-work or subdivisions. In these situations it is common for the design to have a 1 1/2 inch thickness carrying all of the construction traffic for several years. This initial layer gets easily overstressed and even cracked on the underside before it is topped with only an additional 1 inch wearing surface. On the other hand, with a 4 inch design, a 2 1/2 inch layer carries construction traffic adequately. A final 1 1/2 inch layer provides a wearing and exceptionally strong strengthening course, also providing much more longevity to the pavement.

4. With a 4 inch design, pavement strength adjacent to utility cuts and castings is more substantial.

5. Added strength acquired through the use of the minimum 4 inch design provides a safety factor for traffic growth and occasional overload situations. This is particularly helpful when an owner may not have control of the traffic volume, or the funds available to strengthen the pavement.

6. A minimum 4 inch design provides a pavement that will require surface maintenance only. Pavement treatments can be limited to individual crack sealing, liquid seals, and very thin overlays - thicker overlays are required only when traffic growth calls for it.

7. The 4 in. minimum provides sufficient thickness for recycling by milling. When milling 1 in. from a 2 1/2 in. surface to a 1 1/2 in. depth, little stock is left for construction traffic to travel on.

8. Better overall pavement quality and density can be achieved by using more compactible layer thicknesses. This leads to less embrittlement and greater retention of flexibility with time.

9. Although 2 1/2 in. designs have been shown in tests to be sufficient, it should be noted that test road data always reflects better performance than actual practice.

When a 4 in. pavement is overloaded by traffic and cracks, the pavement is thick enough to resist disintegration into small pieces and to resist the type of "flaking out" at the crack that occurs on thinner pavements. This is why you will rarely see overnight potholing occur on a pavement greater than 4 in. thick. If distress is occurring, it will be evident for several years while remaining safe and serviceable. Only total neglect and lack of maintenance will cause it to eventually break down into surface ravelling. However, this surface ravelling or delamination only affects rideability and appearance. It is tolerable from a safety and auto damage point of view.

Once weakened, pavement thicknesses less than 3 to 4 inches can break into pieces and pothole very easily. This is because the pieces are small enough to be turned out by tire traffic. On thicker pavements (about 3 1/2 in. plus) the thick broken pieces act like big paving blocks and are virtually impossible to be rotated out of the hole by traffic. In other words it fails but remains safe for traffic.

Thin pavements are sometimes best restricted to liquid asphalt surface treatments that require frequent maintenance every few years. These asphalt surface treatments are only recommended for very low volume roads, particularly those that do not have significant truck traffic. Such thin pavements must have excellent drainage and be diligently maintained throughout their service life.

For a low maintenance permanent pavement, the thickness used by most all agencies is at least 3 in. The Asphalt Institute has a firm policy of recommending a minimum pavement thickness of 4 in. even for low volume roads.

According to The Asphalt Institute, the minimum permanent pavement thickness when using asphalt hot mix is 4 in. The slab strength of a 4 in.-thick pavement is substantially greater than that of a 2 in., 2 1/2 in., or 3 in. pavement by many times: the load to provide a 1/2 in. deformation on the base is only 400 pounds on a 2 in. pavement; 3,900 pounds on a 4 in. pavement.

(Reprinted from Road Business, University of New Hampshire Technology Transfer Center, Vol. 2, No. 2;...
HOW FEDERAL GUIDELINES INCREASE LOCAL LIABILITY

by Robert L. Morrison, P.E., P.S.
Hancock County, Ohio, Engineer and President of the National Association of County Engineers

Design guides are increasing local liability problems. They say a minister should start his sermon with quotes from scripture. From the county point of view, the first scripture reading is from the 1970 AASHTO Geometric Design Guide for Local Roads and Streets.

One of the early paragraphs states: The use of more liberal values than the minimums set out herein is recommended where it is economically feasible. In the special cases of tight or unusual conditions, it may not be practical to meet even these guide values. In all cases, every effort should be made to get the best possible sight distance, and, above all, proper drainage that is consistent with the terrain, the development (present and anticipated), and funds available.

Keep this thought in mind, and note the words funds available. It continues: Safety is an important factor in all roadway improvements. However, on low-volume roads, it may not be possible to get the obstacle-free roadsides that are desirable. Every effort should be made to provide as much clear roadway as is practical. The use of latter slopes, the use of guardrail, and the judicious use of warning signs will help to achieve roadside safety. Utility poles should be kept close to the right-of-way line and in no case closer than the ditch line or well back of a curb.

It appears in this 1970 scripture reading that funds and good engineering judgement were of prime importance.

In 1982, a report came out in the Federal register (Vol. 47, No. 112), dated Thursday, June 10. It dealt with R.R.R. design standards for highways. It would like to quote from this scripture, beginning with the Genesis summary chapter: The FHWA is revising its regulations to provide a flexible approach to resurfacing, restoration, and rehabilitation (R.R.R.) projects on highways other than freeways. No single geometric design criteria will be adopted for application nationwide. Instead, geometric design criteria and/or procedures will be adopted in each state to ensure that proposed projects meet federal policy objectives. Present regulations require that all federally funded highway improvements meet geometric design criteria adopted for new construction, unless specific exceptions are granted. The primary purpose of R.R.R. is to prolong and preserve the service life of existing facilities; consequently, design criteria for new construction are not particularly appropriate to most R.R.R. projects. This action is necessary to allow the development and adoption of geometric design criteria and/or procedures more appropriate to the scope and purpose of R.R.R. The action should provide more flexibility to meet state and local needs with a less cumbersome federal approval process.

This became effective in July of 1982. In the background material for this ruling, the FHWA discussed the geometric design standards that were available, as quoted previously. They also addressed the geometric design standards from AASHTO, as well as the ability of the state to adopt their own geometric design standards. To that end, it is stated: If a state is not interested in exercising its option under this regulation, it can simply notify the FHWA of its intention to continue operating under geometric design criteria currently adopted for new construction and reconstruction. Standards developed on a national level often provide for uniformity at the expense of local needs and preferences. This is particularly true with regard to R.R.R. work - what works well in one part of the country, or even one area of a state, may be totally unacceptable in another.

In 1982, the FHWA realized that the adopted design standards are not necessarily the answer to local problems and offered the states a solution.

Today’s problems

In Ohio, we use the 1984 AASHTO green book - A Policy on Geometric Design of Highways and Streets. It’s probably one of the finest documents ever put together by our peers. I wish I could afford to design to it.

I purchased the book, but that is all I could afford. I would like to quote from the scripture again, from the forward of this book:

This publication is intended to provide guidance in the design of new and major reconstruction projects. It is not intended as a policy for resurfacing, restoration, or rehabilitation projects.

AASHTO in its wisdom in 1984 again reaffirmed its position, and said this is not the book we should be using for R.R.R. Yet, in Ohio, it is the standard.

We cannot all be doing the same things the same way in every state, county, or township. It simply will not work. Somewhere along the line, if you talk about reasonable engineers designing projects, good engineering judgement and funding has to be taken into consideration.

In a study done in 1986, the Western Illinois University looked at four states - including Ohio. It found that 62.9% of all county roads have an ADT of 0 to 500. In my particular county, 7% of our county system is on the federal secondary system. If you include the township system, for which the county engineer in Ohio has responsibility, that figure drops to...
Policies or Standards?

For some reason, policies have a way of becoming standards. The AASHTO report is a good example. It is a policy. But, in Ohio, it is a standard. It has become the norm by which we are all judged whether those standards really apply to our circumstances or not.

The increase in liability cases is a good case in point. I would like to call your attention to a book that was published in 1985. It's called Killer Roads from Crash to Verdict. Most county engineers live in terror of it.

This book was written by attorneys for attorneys. It is a how-to-sue book.

With respect to design standards, it states:

Road design standards referred to in this book come in two basic categories; guidance systems and design standards. The guidance systems apply to all the information systems on the road. These information systems usually consist of signs, painting on the pavement, guardrails, reflectors, and similar additions to the basic ribbon of concrete. The engineering criteria for those guidance systems are found in the Manual of Uniform Traffic Control Devices (MUTCD), which every state (and federal) highway department updates and issues every few years. For transportation negligence cases dealing with defects in the guidance systems of the road, such as broken warning signs or missing striping, recourse must be had to the issue of the relevant jurisdiction's MUTCD that was in effect at the time of the crash.

Road design standards deal with the actual geometrics of the road, such as how long and sharp the horizontal curves can be, whether vertical curves should start within horizontal curves, and how many things the road should be doing to the driver at the same time. The most definitive road design standards in the United States have, for several decades, been found in the red, blue, and yellow books issued by the American Association of State Highway Transportation Officials...For crashes dealing with negligence in the design of a roadway, recourse must be had to the AASHTO design standards in effect at that point in the past when (as defendants will argue) the road was designed and built, or (as plaintiff's will argue) when the road should have been updated and improved, prior to the time the plaintiff received his injuries.

Note the words should have been updated! The problem is that regardless of whether we have adopted a standard or not, we are being measured by AASHTO and FHWA policy. This is why we are being sued.

It is difficult to sit in a witness chair and explain why you didn't do anything on a roadway. Money or the lack of it is not an excuse.

In Ohio, we solved the money problem very simply. The legislature gave the county the right to piggy back an increase in license fees, but they also gave the electorate the right of referendum.

Now, we are caught in a Catch 22 between a standard that states "you will do it this way," and the realities of life when the electorate says, "but we ain't gonna pay for it."  

What do you do? You are still sitting in the same witness chair with the same people screaming about the green book, the blue book, and the yellow book. They say, "Why don't you do your job?" We reply we don't have the money to meet the standard.

They say, "You can afford to pay this guy $2 million damages, but you can't afford to fix the problem." Well, we can't afford to do either.

Some place along the line, the standards have to be personalized and humanized. That's the reason I like the TRB Special Report 214. To me, it's humanized. We can't continue to live with the hard and fast rules we have in place now and survive - in or out of the courtroom. We won't make it. If others are going to set the policies and standards by which we are judged, then it follows they must also provide the funds to meet these standards.

(From Better Roads, April 1988)

ACKNOWLEDGEMENT

The Technology Transfer (T²) Program is a nationwide effort financed jointly by the Federal Highway Administration and Individual State Departments of Transportation. Its purpose is to translate into understandable terms the latest state-of-the-art technologies in the areas of roads, bridges, and public transportation, to local highway and transportation personnel.

The T² Center at Georgia Tech is sponsored by the Georgia Department of Transportation and provides information and counsel to more than 500 municipalities and counties in our state. This newsletter is designed to keep you informed about new publications, new techniques, and new training opportunities that may be helpful to you and your community. Individuals wishing to receive future copies of this newsletter at no cost may send their requests to:

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DO IT RIGHT THE FIRST TIME
AND GET RID OF POTHOLES

Many highway engineers agree that the usual
techniques for pothole patching are little more than
exercises in futility. Nevertheless, those who use these
procedures claim that more permanent repairs are not
cost-effective because maintenance personnel must
spend too much time preparing the hole, compacting
the mix, etc.

In terms of dollars spent, this is penny-wise but
pound foolish. If the pothole is not permanently patched
the first time, more repair trips must be made. Each
time the same pothole is patched, its expense increases.

REPAIR PROCEDURE

There are seven basic steps to pothole patching. Some
steps can be adjusted to the conditions that exist,
but for the most part, all steps must be closely followed
to have a long lasting patch.

Of course, before the patching begins, make certain
that this is the correct procedure. For example, in badly
deteriorated sections, a complete overlay may be
required. A primary concern should be the safety of the
repair.

1. **Marketing.** The area around the pothole must
be marked with chalk or paint so the workman doing the
cutting can easily and quickly remove the failed material.
Marking is done to include only portions of the
pavement that will provide a good surface against which
the patch is to bond; these portions should have no
cracks and appear solid compared to the area immedi-
ately adjacent to the pothole.

2. **Cutting.** The workman doing the cutting should
avoid cutting more than marked. Excess cutting
reduces material use. The walls of the hole should be
made vertical to provide a good surface for adhesion
and "locking" the patch in during compaction.
Cutting should continue to a depth where good
pavement or base material exists. If the pavement cut
away is to be recycled, care should be taken to avoid
including base and subbase material to prevent con-
tamination of the mix.

When cutting is complete the large chunks of
pavement should be removed and stockpiled, if not used
immediately, for future recycling.

3. **Cleaning.** This step includes removing any
remaining debris from the hole. Compressed air works
well for this. If the hole has been made down to the
base or subbase, these materials, if disturbed, must be
compacted so that compaction by traffic will not occur
after the patch is in place.

If the hole has water in it, the bonding of the
patch will be poor. The hole must be dried as much as
possible by using compressed air, a torch, rags, broom,
etc. It is very important that all debris be removed from
the sides of the hole. Loose material will cause a poor
bond and lead to early failure of the patch.

4. **Tacking.** A tack coat, which provides a bond
between old and new surfaces, should be used. Too
much tack coat will result in an excess amount of
asphalt, which will lead to rutting and eventual failure of
the patch.

Hot mix, as well as recycled mix or cold mix,
should always be tacked. The best method for tacking
is to spray the tack in a thin coat. Brooming and
pouring are generally not effective because excess tack
material usually accumulates at the bottom of the hole
around the edges.

5. **Placing.** Holes deeper than six inches should
be filled and compacted in more than one layer. Placing
should be done with a shovel in one lift working from
one side of the patch to the other. To prevent segrega-
tion, the material should be laid, not thrown or raked,
into the hole.

The patch should be made so that after final com-
pletion, it is slightly above the surrounding pavement
(about 1/8 in.) to allow possible future compaction by
traffic and eliminate "birdbaths" (depressions in the
roadway caused by traffic). No patching materials
should be left on the surrounding surface.

6. **Compaction.** It is crucial that the patch be
compacted properly. Poor compaction will cause
shrinkage of the patch, allowing intrusion of water
around the edges and ultimate failure. The compaction
method should match the size of the repair. A one
square foot patch does not require compaction with a 10
ton tandem steel-wheeled roller.

Most road repairs can be made with small to med-
ium sized vibrating plate or roller compactors. Care
should be taken by the operator to insure that the
compaction force is directed on the patch and not the surrounding pavement.

7. **Edge Sealing.** Edge sealing is done to keep water out of the joint between pavement and patch. Any material can be used, so long as it does not cause excess asphalt to bleed around the patch. A layer of fine sand can be used to blot the seal. Ideally, pavements should be maintained so they will not deteriorate to the point where potholing occurs.

**PAVEMENT MANAGEMENT SYSTEMS** provide detailed information about the road network to the manager so that decisions about maintenance can be made. Highway administrators and engineers should take the initiative and explore this new technology.

(This article is based on **Cold Regions Technical Digest No. 84-1, March 1984,** entitled "The Engineer's Pothole Repair Guide." Free copies of the booklet are available from Mr. Robert Eaton, Civil Engineering, Geotechnical Research Branch, USA Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire, 03775-1290.

(From Technotes, University of Maryland Technology Transfer Newsletter, Spring 1986.)

THE ART OF WRITING SPECS

There are steps that can be taken to facilitate the process of writing specifications for equipment purchases:

1) Work closely with the purchasing department—let them know what you wish to do with the equipment; let them know if you’re having problems with what you’ve received in the past so that the same problems won’t be bought in the future.

2) Identify your minimum requirements, don’t make a wish list of expensive optional features.

3) Consider using performance-based specifications based on how well a product does the job and at what cost.

4) Require a demonstration if you are unfamiliar with a vendor’s product.

5) Don’t leave the vendor guessing—state in the opening paragraph of the specification how the machine will be used and under what conditions.

6) Don’t be afraid to ask for help—other agencies can provide assistance from their experiences.

These are suggestions taken from APWA’s Public Works Pro-Views on Equipment Services, 1987.

DOT RULE ALLOWS UTILITIES ALONG HIGHWAYS

The U.S. Department of Transportation has issued a final rule that permits states to decide whether to allow certain types of utilities, such as fiber-optic communication cables, telephone lines, fire and police signal systems, cable TV lines and water mains, to be installed along freeway and interstate highway rights-of-way.

Prior to this rule, the federal government had to approve every single request by a utility to use the rights-of-way even though the rights-of-way are owned by the individual state.

"The states are perfectly capable of deciding whether utilities may use state-owned rights-of-ways. So long as highway safety standards are maintained, there is no reason for the federal government to be involved in each and every decision," DOT Secretary Jim Burnley said.

The rule requires the states to submit a plan setting forth the state’s policy on the installation of utilities within freeway rights-of-way. A state can decide not to permit installation along the freeway, but this must be expressed in its plan. If the state elects to permit the installation of utilities within the highway property line, it must demonstrate the precautions that will be taken to protect highway safety. Once a state plan is approved by the FHWA, individual requests will no longer require FHWA approval on a case-by-case basis.

Under the old regulation, which required FHWA approval for each installation request, few utilities were allowed to be located along the rights-of-way. FHWA estimates that only about 250 requests have been granted nationwide since 1960, and these grants generally have been for very short segments of several thousand feet or less.

FHWA’s rule making will enable a new generation of sophisticated communications equipment—with significantly increased network capacity—to serve the growing communication needs of the country, while, at the same time, providing greater cost savings to the public.

(From U.S. Highways, U.S. DOT, Winter 1988.)
EDITOR'S NOTE

There are few things in life that are more enjoyable than the sharing of information. For the past several years, the Georgia Tech Technology Transfer Center has provided me the opportunity to share information with numerous city and county agencies throughout the State of Georgia.

The Center has gained a significance in my daily activities that I would not have guessed would happen when the project began. Now, it has been decided that the Center at Georgia Tech will be moved to the Georgia Department of Transportation (GDOT). Although, we are closing are doors at Georgia Tech, Technology Transfer for Local Transportation Agencies will continue. Mr Phil Bryant the GDOT Training Officer has assumed the responsibilities of Technology Transfer. Requests for information, assistance, reports, and training should be addressed to:

Mr. Phil Bryant
Training Officer
Georgia Dept. of Transportation
Room 268
No. 2 Capitol Square
Atlanta, Georgia 30334
404/656-5181

It is also my understanding that Mr. Bryant will be scheduling training workshops for local agencies in the near future. On-site training sessions will continue. Consequently, I suggest that you connect Mr. Bryant to arrange a training topic and time for your local agency.

I believe that the Technology Transfer Program in the State of Georgia is a Local Program. It is intended to assist the local agencies to improve their productivity and achieve greater mileage for their dollar investment. Consequently, I suggest that you continue to take advantage of the Program. The GDOT through Mr. Bryant's office will continue to offer the same services as have been offered by the Georgia Tech Center. To continue a successful Program your involvement in the Program is necessary. It is up to you to avail your agency of the many beneficial opportunities.

On behalf of all of the staff that have worked at the Georgia Tech Technology Transfer Center, I would like to say thank-you for this opportunity to share information. It has been a tremendous learning experience for me. Hopefully, you can say the same. I am confident that the GDOT will continue what has been started and provide even more services than in the past. I wish them the best of fortune in the coming years.

Remember that this is your program and you must take advantage of the services that are provided. I have had many memorable experiences during the past several years. Again, thank-you. It has been a pleasure working with you.
NEWS BRIEFS

The U.S. Department of Transportation has proposed mandating drug testing for more than 350,000 mass transit, merchant marine, and pipeline industry workers. Under the DOT proposal, mass transit systems that fail to implement a program would be ineligible for federal funding.

A Notice of Proposed Rulemaking issued by the DOT sought comments on various methods of detecting drug use by transportation employees. These include preemployment, post-accident, random, reasonable cause, and periodic testing for employees as part of a comprehensive program that included education and rehabilitation.

Texas officials have used a fly ash/sand/aggregate mortar for pothole patching in both wet and dry weather. The mortar hardens quickly, supporting the weight of a car in 10 minutes. Reports of the mixture's use led to experiments at the Center for Transportation Research, University of Texas, where test results showed that the optimum mix is two parts fly ash, one part sand, and two parts coarse aggregate. Field tests showed that pothole skies do not have to be squared up and that the mortar can be mixed in the pothole.

In Finland, England, and Sweden, convicted drunk drivers are automatically jailed for approximately one year. The names of convicted drunk drivers in Australia are published in local newspapers. In South Africa, chronic offenders face a maximum penalty of a ten-year prison sentence, a fine of $10,000, or both. In Turkey, drunk drivers are taken 20 miles from town and forced to walk back under escort. A second conviction of drunk driving in Bulgaria is punished by execution.

Since federal penalties on state motorcycle helmet laws have been lifted, a number of states have repealed their state laws requiring motorcyclists to wear helmets.

A recent survey in Seattle revealed that of 105 motorcycle accidents, the total amount of dollars spent, including rehabilitation, was more than $2.7 million. That amount less than 1% was paid by the family, 22% was paid through insurance companies, leaving 63% to be paid by taxes.

A larger glass bead, called "Visibeads," stands up above the accumulated water and is more visible on wet nights than ordinary glass beads, according to Potters Industries, developer of the beads. They have nine times the surface of other beads.

The new beads add about 5% in costs over the life of a marking line when used in epoxy, and about 25% more in thermoplastic, according to Potters.

Tests show that Visibeads are more visible in dry conditions than standard beads. During wet conditions, visibility drops for both beads; however, when rain stops, recovery is much more rapid, within seconds, for the new, larger beads. Tests also show that Visibeads maintain their reflectivity longer than standard beads in dry, as well as wet, conditions.

A tree within 30 feet of a driving lane is hit on an average of once every 20 years. If the tree is closer than 30 feet or in a median, it is hit more often. Single vehicle "run off the road" type accidents were responsible for approximately 50 percent of all traffic deaths. A "forgiving" roadside, clear of obstacles should be strived for.

Traffic signs rank as the most cost-effective accident countermeasure, according to a Highway Safety Evaluation, published by the Federal Highway Administration. Lawsuits over substandard traffic signs that do not meet MUTCD standards, or the failure to use signs where appropriate, are on the rise. Upgrading signs on local roads can be a cheap insurance policy, reducing accidents and loss of life and, at the same time, minimizing exposure to liability.

Eighty-two billion dollars will be needed by the year 2000 just to maintain overall conditions on non-local highways and bridges and to provide public assistance for urban transit systems, according to the U.S. Department of Transportation. This estimate is conservative and does not allow for the doubling of travel in many areas by the year 2000. In New York, about 70 percent of all personal travel is by automobile and three-quarters of total freight volumes are transported by truck. By 2000, highway travel is expected to increase from the current level of 95 billion vehicle miles to 130 billion vehicle miles.

Recommended speeds for curves often are determined by the use of a ball-bank indicator mounted in a car and set at zero when the car is level. Trial runs are made and recommended speeds set depending on the degree of deflection from zero. The following recommended speed/ball-bank reading relationship has been suggested: 14-degree maximum deflection for recommended speeds of 15 mph or below; 12 degrees for speeds of 20 to 30 mph; and 10 degrees for recommended speeds of 35 mph or greater. A recent review by R. L. Carstens in the Iowa State University publication, "Technology News," suggests that the trial runs should be in both directions and the recommended
speed would be the lower of the two runs. It is suggested that the trial runs be carried out in a typical vehicle such as a passenger sedan. Research shows that readings do fluctuate widely during trial runs and that the "most frequent" reading is the one to use. Vehicle suspension systems, for example, are just one factor that can affect the reading. Carstens cautions that in the final analysis, the engineering judgement and experience of the rater are critical in setting the recommended speed.

GRAB YOUR COFFEE CAN: FIGURE LOST GRAVEL COST

Question: How can you save $50,000 per motor grader operator per year?

Answer: Train your operators to properly pick up windrows of gravel.

Some do-it-yourself coffee-can research by Ed Wootton, of Nebraska's T2 Center, led to this conclusion. As he watched motor grader operators at work, Ed wondered about the cost of the gravel lost off the toe of moldboards as windrows were picked up.

So he measured one foot in the ditch and put all the spilled gravel he found in that area in a coffee can. When he weighed the can he found he had two pounds of gravel (which he says is a very minimal loss—often it is much more).

At that rate, the gravel loss is 10,560 pounds in one mile. If an operator grades 20 miles a day, he loses 105.5 tons. At $3.65 per ton, the dollar loss is $385.44 per day.

If the operator works 22 days per month and devotes half of his time to his job during the year, the total dollar amount of lost gravel is $50,878—two and a half times the salary of an average operator.

The main cause of this loss, Ed says, is improper blade angle. "We know there are other factors in the loss, such as wind, water, and heavy traffic, but the chief cause is improper procedures."

The spilled gravel is partially retrievable by pulling up the slopes, but that is time-consuming and costly, and "you don’t get it all."

Here’s Ed’s formula if you want to measure your own losses:

1. Weigh gravel collected from one foot of ditch.
2. x 5,280 (feet per mile).
3. x number of miles per day per machine.
4. x number of days worked per year.
5. x number of machines used.
6. cost per ton of gravel.


**PUBLICATIONS**

* The Transportation Research Board (TRB) has released a report on the relationship between safety and key highway features. The report describes the continuing controversy over which minimum geometric standards should be applied to resurfacing, restoration, and rehabilitation projects. Various organizations have proposed standards but none have been adopted for nationwide use. However, at Congress’ request, TRB studied the problem and published Special Report 214, Designing Safer Roads—Practices for Resurfacing, Restoration, and Rehabilitation. Topics include curvature, sight distance, land width, shoulder width, intersection, pavement-edge drop, and pavement resurfacing. Copies are $14 each. To order, contact Transportation Research Board, National Research Council, 2101 Constitution Avenue N.W., Washington, DC 20418.

* In addition, TRB has released a report entitled Low-Temperature Properties of Paving Asphalt Cements. It is designed to foster a better understanding of factors affecting low-temperature behavior of flexible pavements. Copies are available for $5 each from TRB, 2101 Constitution Avenue, N.W., Washington, DC 20418.

* A new video prepared by the FHWA and NACE is now available. Entitled Blading Unpaved Roads, the video is 22 minutes long and is based on NACE’s Blading Aggregate Surfaces training guide. For more information concerning this video, contact Milton Johnson, Executive Secretary, NACE, 326 Pike Road, Ottumwa, IA 52501; 515/684-6928.

**MAINTENANCE TIPS**

**UNPAVED SHOULDER REPAIR**

**RESHAPING SHOULDERS**

When rutting, corrugations, or ridges occur on an unpaved shoulder, the reshaping of the shoulder becomes necessary. Ruts, corrugations, and ridges in earth shoulders are caused by erosion and/or improper compaction of the shoulder materials. These deficiencies are normally found in shoulders with slopes greater than 5:1 and in shoulders that have little or no ground cover to prevent erosion. Corrugations may show up in newly reconditioned shoulders within 6 months after construction. Initial ruts, corrugations, and ridges are not a severe deficiency. However, if they are allowed to remain they will create drainage problems that may result in areas of low shoulder and hazardous driving conditions for vehicles.

Crew required:

- **Equipment operator** 1
- **Laborers** 2
- **Flagmen** 1

Equipment required:

- **Motor grader** 1

Material required:

- **None**

Repair procedure:

1. Place signs and other safety control devices.
2. Remove roadway signs and mailboxes from shoulder to be repaired.
3. Cut high spots with motor grader, pulling material toward the roadway.
4. Blade the material back onto the shoulder, making sure all low spots are filled. Make certain the new shoulder is level with the adjacent pavement and sloped toward the ditch to permit drainage of water.
5. Roll with motor grader wheels to compact loose material.
6. Replace signs and mailboxes.
7. Clean up area and remove signs.

**RECONDITIONING SHOULDERS**

When unpaved shoulders are high, low, or narrow, they should be repaired by reconditioning the shoulder. High shoulders are those in which the shoulder surface is higher than the adjacent pavement, preventing pavement drainage. They are caused by buildup of vegetation along the shoulder or improper drainage or shoulder allowing the buildup of earth.

A low shoulder is one where the surface of the shoulder below the surface of the adjoining pavement. It is caused by a build up of the pavement surface and settlement or erosion of the shoulder. Often pavements are overlaid causing a rise above the shoulder equal to the depth of the overlay. This condition creates a safety hazard for the driver. Low shoulders may also result in wide gaps at the pavement-shoulder joint, allowing water to penetrate into the subgrade and cause edge or alligator cracking.

Narrow shoulders are those which are too narrow to permit a vehicle from pulling completely clear of the roadway (less than 8 feet wide). Most narrow shoulders are the result of insufficient width of right-of-way at time of construction or decrease of shoulder width due to widening of the pavement. Narrow shoulders are not a serious deficiency as long as a minimum shoulder width of 4 feet is maintained at all times and areas 8 feet wide are provided at intervals of every one-half to one mile.

Crew required:

- **Equipment operators** 2
- **Truck drivers** 2-4
- **Laborers** 2
- **Flagmen** 2

Equipment required:

- **Dump trucks** 2-4
- **Roller** 1
- **Motor grader** 1
- **Front end loader** 1

Material required:

- **Gravel or imported borrow**

Repair procedure:

1. Place signs and other safety control devices.
2. Remove roadway signs and mailboxes on shoulder.
3. Cut shoulder wedge approximately 4 inches deep at pavement edge and slope to desired shoulder width (8 foot minimum if right-of-way available, 4 foot absolute minimum).
4. Work material cut from shoulder back into wedge. If additional material is required, spread material from truck, and work in with motor grader. If excess material at shoulder, remove and haul away.
5. Shape shoulder with motor grader to conform with roadway and slope toward ditch.
6. Roll as required for proper compaction.
7. Replace roadway signs and mailboxes.
8. Clean up area and remove signs.
"To See or Not to See" Should Not Be the Question

There are situations where sight distances from one street to an intersecting street are poor because the street is depressed and the adjacent corner has retaining walls, buildings are close to the property line, or there is heavy vegetation. Frequently, such obstructions are either impossible or very costly to remove. A solution to this condition using mirrors has been tested at two intersections in Commerce City, Colorado. One of these is shown in the sketch. The location is a residential area. The intersection is a four-way stop, but southbound traffic (upward on the sketch) had poor visibility to traffic coming from the right on 61st Avenue because of a raised front yard and a 4-foot retaining wall. The remedy was placing a convex mirror on the far right corner which gives a more complete view of 61st Avenue to the right and thus permits a more cautious entry into the intersection. The metal mirrors cost only about $150. The mirrors have been in place at two intersections for 15 months and no accidents have occurred during that period.

From "Road Business," Technology Transfer Center, University of New Hampshire, Summer, 1988.

MICROCOMPUTER PROGRAMS AVAILABLE FOR SOLVING LOCAL SAFETY PROBLEMS

Local jurisdictions are faced with the responsibility for highway safety programs and improvements. Because of the absence of data on locally maintained roads and delays in obtaining centralized data, state highway accident data bases are not always sufficient.

According to a technical summary by the Federal Highway Administration, computer software is now available for use by local jurisdictions to develop, monitor, and evaluate their highway safety programs. The software is intended primarily for use by jurisdictions with populations up to 500,000 persons.

The computer software has two parts: Highway Safety Analysis and Monitoring (HISAM) and Highway Safety Evaluation (HISAFE). HISAM provides the framework for a safety information system. It is used to enter, edit, and maintain accident reports, street inventory data, and traffic volume data. It contains subroutines for identifying high accident location, analyzing accident characteristics, and producing standard accident reports. HISAFE evaluates the effectiveness of completed safety projects. It contains subroutines to aid the user in computing accident rates and percent changes resulting from safety improvements, performing statistical significance testing, and conducting economic evaluations of the effects of safety improvements. Both software packages operate on IBM PC or PC-AT and other IBM compatible microcomputers and are modular in design. Because the programs are menu-driven, the user needs no computer programming background.

The city of Charlotte, North Carolina, population 350,000, has successfully tested and is currently using the software. The results of the study are presented in four main sources. A Final Report (FHWA/RD-87/072) provides general background on the computer program. Two manuals document and describe the details on how users can run either HISAM (FHWA/RD-87/073) or HISAFE (FHWA/RD-87/074), and a Techshare Report (FHWA-TS-87-211) summarizes the field test experience along with the advantages and limitation of the program. All of these documents are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161.

The computer software, available on IBM-compatible 5 1/4" diskettes, and users manuals can be obtained from the Center for Microcomputers in Transportation (McTrans Center), 512 Weil Hall, University of Florida, Gainesville, Florida 32611. The telephone number is (304) 392-0378. There is a small charge for items ordered from the McTrans Center.

From "Technology Exchange," a Rural Technical Assistance Program of Louisiana State University, Spring, 1988.
TORT LIABILITY: A MAJOR CONCERN FOR TRANSPORTATION AGENCIES

Is there a safeguard against torts?

"Since there is not a way to eliminate liability or prevent suits, engineers must do the next best thing—they must minimize their liability exposure."

The issue of tort liability has become a major concern for municipal, state, and federal highway agencies. In increasing numbers, citizens are suing transportation agencies over substandard roadways which may have resulted in damage to property or bodily injury.

It is important that highway personnel, from the workzone crew to top officials, understand not only the issue of tort liability but an agency's discretionary powers in reference to tort liability, and what that agency can do to prevent torts from arising.

A tort is a private or civil wrong, independent of contract. It is an overt act or omission that results in an injury, loss, or decrease in property value. Not a criminal act, for the injury or loss was not intentional, it occurred because someone failed to act in a reasonable, prudent fashion. The purpose of a legal action or lawsuit in cases of tort is to compensate the victim by the payment of a sum of money. In a civil suit, the plaintiff must only convince the jury that the defendant was in some way more wrong than the plaintiff and caused injury or property loss to the plaintiff.

In the case of responsibility of transportation agencies, the law requires only that governments maintain their road systems in a reasonable safe condition. When the government creates an extraordinary situation that causes personal injury or property loss, it has failed in the duty owed to the user, and the spectre of tort liability arises.

In past civil cases, the court looked at the governmental function and determined that some of the functions should be considered discretionary acts, and some should be considered nondiscretionary acts. A discretionary act is one which meets the following criteria: (1) an authorized individual or agency must have been given the power and duty to make a decision; (2) the decision must be made from a set of valid alternatives; and (3) the individual or agency must exercise independent judgement in making the selection. Therefore, if a government act was determined to be discretionary, the government would continue to be immune to prosecution. However, if the act was determined to be nondiscretionary, the government would now be liable.

To avoid charges of abuse of discretionary power, engineers are cautioned to ensure that (1) they have the authority to make a decision, (2) the decision is made from valid alternatives, and (3) the decision is made by an exercise of independent judgement.

The court's decisions have been fairly uniform in holding that the design of a highway is discretionary because it involves high-level planning and evaluation of policies. Design immunity is intended to immunize governmental bodies and employees from liability arising out of negligence or errors in a plan or design when the plan or design was duly approved under current standards of reasonable safety.

Negligent construction is not likely to be immune from liability by reason of the discretionary function exemption, particularly where the construction deviates from the approved plan or design, or where there is negligence in implementing the plan or design. Construction negligence might be immune when it resulted from following a plan or design that specified in elaborate detail how a feature was to be built.

Negligent maintenance is least likely to be immune from liability because maintenance is considered a routine function necessary in the performance of normal government administration.

To reduce risk potential, construction and maintenance tasks should be performed in accordance with clearly established guidelines. Establish priority lists to help the government agency properly allocate limited resources. Establishing this priority list does not totally protect the agency from suits alleging that the agency had knowledge of the defect. The agency must have clear, valid alternatives in order to retain discretionary immunity.

Within the construction and maintenance functions, the selection of materials is often viewed as discretionary and therefore immune from suit. If an agency selects a particular material knowing that the material is inadequate, it can be considered to have abused its discretion. In an action to recover damages for injuries sustained or death incurred by reason of a defective highway condition, the burden rests on the plaintiff to establish that such a condition was the proximate cause of injury or death. They must also prove that the public agency having jurisdiction and control over the highway wherein the defect existed had actual or constructive notice of the defect and sufficient time to take corrective action.

The agency responsible for the road system has a duty to maintain the roads in a reasonably safe condition. Individual employees of that agency have the same duty. Legal doctrines hold that all individuals have a duty to conduct themselves in a manner that does not cause harm to any other person. If an individual employee violated this general duty of reasonable care, and if that violation is the proximate cause of an injury or loss suffered by a member of the public, the employee may be named either as the party in the suit or as a party along with the agency.

On the other hand, just as an agency has immunities, the individual employee has the same immunities, particularly within the area of discretionary duties. If the act performed by the employee is considered a discretionary act, then the employee may
have the generally accepted government immunity. However, employees involved in nondiscretionary activities, which include construction, maintenance, and even the operation of a government vehicle, may face the same liability exposure that private individuals would face.

Since there is no way to eliminate liability or prevent suits, engineers must do the next best thing—they must minimize their liability exposure. A good risk minimization program is a preventive program. It will anticipate the high-frequency problems that engineers face in maintaining a reasonably safe road system for the user by identifying those problems and establishing programs to eliminate them. Good records are the foundations of any good risk minimization program.

A good preventive maintenance program seeks out problems in the field and does not rely entirely on complaints from the public or various police agencies. A good program further establishes lines of communications between the various parties who will be designated to help identify problems and the appropriate maintaining agency.

As a further measure, the agency should also establish a regular inventory and inspection program to seek out problems that could be hazardous and indicate negligence on the agency's part.

Tort liability will always exist to some measure. But by taking all possible precautions, an agency can be successful in at least minimizing its liability.

From "Technology Exchange", A Rural Technical Assistance Program of Louisiana State University.

ACKNOWLEDGEMENT

The Technology Transfer (T²) Program is a nationwide effort financed jointly by the Federal Highway Administration and individual State Departments of Transportation. Its purpose is to translate into understandable terms the latest state-of-the-art technologies in the areas of roads, bridges, and public transportation, to local highway and transportation personnel.

The T² Center at Georgia Tech is sponsored by the Georgia Department of Transportation and provides information and counsel to more than 500 municipalities and counties in our state. This newsletter is designed to keep you informed about new publications, new techniques, and new training opportunities that may be helpful to you and your community. Individuals wishing to receive future copies of this newsletter at no cost may send their request to:

Mr. Phil Bryant
Training Officer
Georgia Dept. of Transportation
Room 268
No. 2 Capitol Square
Atlanta, Georgia 30334
404/656-5181

BUYING MICROCOMPUTERS

When requesting microcomputer bids, a number of tips can help ensure purchase of a truly useful, as well as low-cost system.

TIP 1: In the specifications, describe the uses your department plans for the system, including an outline of the functions of the department.

TIP 2: Specify software that must run on the system as well as basic software needs, such as word processing, an electronic spreadsheet, BASIC, and so on.

TIP 3: Specify computer features required, such as one or more serial ports, parallel port and graphics board.

TIP 4: Specify a high resolution color monitor if needed.

TIP 5: Specify minimum size of internal RAM, usually from 256 to 640 K.

TIP 6: Specify size of a hard disk drive, if needed.

TIP 7: Specify quality of printout for printers—laser, dot matrix, letter quality or daisy wheel—along with any specific type font or size requirements, such as subscript or superscript capacity.

TIP 8: Specify minimum printer speed. Dot matrix printers are usually faster than daisy wheel units, with a typical speed of 200 characters per second for normal type faces, and 100 character per second for emphasized printing. Near-letter-quality printing speed may be 40 character per second or less.

TIP 9: Specify furniture, accessories and supplies needed, such as printer stands, cables, diskettes, paper and ribbons.

TIP 10: Specify local service requirements.

TIP 11: Specify degree of aftersales support required.

TIP 12: Specify compatibility needs, to interface with an in-department mainframe, if one is used.

DON'T GET ZAPPED

Flash! Kaboom! The zig-zag of lightning and the crash of thunder are not particularly significant for most of us because we take adequate precautions. Your personal safety may be adequate, but what about your computer?

A lightning strike miles away can be transmitted directly to your computer, doing dastardly things to the hardware, software, and precious data. A nearby hit can turn your whole system into a smoldering doorstop. Aside from the perils of lightning, momentary power outages and routine power surges can also cause problems. So how can you protect your investment?

You can purchase a surge protector from your computer dealer or electronics store that will offer some protection. The degree of protection varies from model to model, with the greatest protection usually afforded by the most expensive models. In addition, most models offer conveniences like multi-outlets which allow you to plug in (and protect) all of your peripheral equipment as well. Some also have built-in circuit breakers to protect against overloads, and a master on/off switch. Prices range from about $20 to $100, a small price to pay for protection.

Adapted from the "Technology Transfer Quarterly," Transportation Research Center, University of Florida, Fall 1988.
APPENDIX E--Evaluation Reports

- Georgia Tech Technology Transfer Center Evaluation Questionnaire Summary - Prepared by Georgia Department of Transportation, Office of Materials and Research, Mr. Peter Malphurs, August, 1988.

DEPARTMENT OF TRANSPORTATION  
STATE OF GEORGIA  

INTERDEPARTMENT CORRESPONDENCE  

FILE  
OFFICE Materials & Research  
Forest Park, Georgia  
DATE August 24, 1988  

FROM Peter Malphurs, State Materials & Research Engineer  
TO Hal Rives, Commissioner  

SUBJECT Georgia Tech Technology Transfer Center Evaluation Questionnaire Summary  

I have received completed questionnaires from 76 counties for a 48% return. Responses were also received from 11 cities. Of the 87 responses, 66 want the program to continue, 10 are neutral, and 11 do not want the program to continue. A county outline map is attached showing the responses for all counties except four which were unknown. We were looking for any pattern which might show up, but none was found. A distribution of responses by county population is included as Attachment 2. Eighteen of the 22 most populous counties (greater than 50,000) responded with 17 of the 18 wanting the program to continue. Responses dropped as population decreased with a higher proportion of these counties having less interest in the program.

Attachment 3 is a copy of the questionnaire with responses totalled. Question 2 asks about any increase in productivity due to the Technology Transfer Program. Eleven responses showed a 10-15% increase, 24 a 5-9% increase, 25 a 1-4% increase, and only 5 indicating no increase in productivity.

The idea of conducting workshops at individual county shops was very popular. All 71 of those who completed the whole questionnaire indicated that they would be willing to attend a 2-hour workshop.

Attachment 4 is a summary of the programs counties would like to see and other general comments. They suggested a number of topics which will give the Technology Transfer Center ideas for new workshops. The most popular topics were bridges, pavement design and pavement maintenance. Under general comments, ten questionnaires specifically mentioned that workshops should be offered locally.

Attachment 5 is a summary of the questionnaires by county and is included for your information.

PM:PBM:ccj  
Attachments
Legend:

- Counties that replied, YES - "program to continue"*, 66
- Counties neutral, reply blank, - "program to continue", 10
- Counties that replied NO - "program to continue", 11

* question 4. in questionnaire, "Should the T² Center continue to provide services to cities and counties?"
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Legend:

- Counties that replied, YES - "program to continue", 66
- Counties neutral, reply blank, - "program to continue", 10
- Counties that replied NO - "program to continue", 11

* question 4. in questionnaire, "Should the T² Center continue to provide services to cities and counties?"

Summarized by Research & Development Bureau, Office of Materials & Research
25 August 1988
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1. Has your jurisdiction used the services of the T² Center?
   Yes 66
   No 21

   If No, why not?

   If Yes, what services have you used?
   55 Attended T² Workshops
   58 Received and Read Newsletter
   27 Received Publications and/or Technical Assistance.

2. Have the services of the T² Center been of value?
   Yes 62
   No 9

   If No, why not?

   If Yes, how have the services of the T² Center changed the Transportation related work productivity of your agency?
   11 10-15% Increase in Productivity
   24 5-9% Increase in Productivity
   25 1-4% Increase in Productivity
   5 0% Little or No Increase in Productivity

3. Rank the services that have resulted in increased productivity. Put "0" if of no value.
   53 Workshops
   48 Newsletters
   40 Publications
   32 Assistance

   Totals Only - See Attachment 5 for ranking
4. Should the T² Center continue to provide services to cities and counties?
   
   Yes 66
   No 11

5. If it continues, should the T² Center provide workshops that could be conducted at your shop?
   
   Yes 69
   No 11

   If Yes, would you be willing to send (allow) your Roadway Crew to attend a two-hour workshop?
   
   Yes 71
   No 0

6. What other topics or programs could be offered that would benefit you?
   
   See Attachment 4.
Summary of Counties' Responses on Question 6: "What other topics or programs could be offered that would benefit you?"

Information is listed alphabetically by subjects and the number of times mentioned by different counties so noted. General comments are presented at the end.

Bridges: Inspection (3); Maintenance (3); Repair (3), of wooden bridges (1)
Construction: Contract Administration; Supervision and Testing
Data Management/Computer Training
Drainage (2)
Equipment Maintenance (1), Heavy Equipment Maintenance (1)
Guardrail, including bridge approaches
Liability
Hydrology training
Mapping & CAD related to surveying
Pavement Design: Roadways (3), Streets (2) and Intersections; Rehabilitation Alternatives; CAD; Base Applications
Pavement Evaluation: Road Inventory systems; operations
Pavement Maintenance: Roads (4); Dirt Roads (4); and Dust Control
Potholes (2)
Risk Management
Right of Way, acquisition
Traffic Safety (2): Traffic Control; Flagging & Sealing Off Roads, Worksite Safety
Traffic Signs (2) and Signals & Sign Theft Prevention
Transportation: Design; Engineering
Utility Cuts and Repairs
Vegetation, Roadside: Establishment; Management (2); Mowing, Shoulders
Waste: Energy Programs; water applications to land

General Comments:
- Workshops should be offered locally (10)
- T2 personnel need to be "in the field" for more personal help
- Workshops for maintenance and construction personnel
- Technical assistance is the most important service
- Public Works, the term, needs to be defined re normal and frequency
- T2 needs better library for completed research on safety programs
- VCR training films need for local training classes (2)
- Publications/Information on GDOT accepted methods/materials
- System for sharing ideas/problems between counties of comparative size with similar problems
- Waive registration fees
- Comprehensive funding packages for improvements
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<td>N. Johnson</td>
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<td>K. Martin</td>
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*Note:* Data for each person includes participation in various activities as indicated by checkmarks.
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EVALUATION OF
GEORGIA TECH TECHNOLOGY TRANSFER PROGRAM

Prepared by
Grover Bowman
April 1988

Submitted to
Georgia Department of Transportation
Research and Materials Laboratory
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Appendix A—Blank Questionnaire

Appendix B—Summary of Questionnaire Data

Appendix C—Completed Questionnaires (submitted under separate cover)

Appendix D—Evaluation Questionnaire Summary
SUMMARY

Accomplishment of this consulting agreement for the Georgia Tech Technology Transfer ($T^2$) Center has resulted in fifty-seven interviews being conducted in forty-five of Georgia’s one-hundred-fifty-nine counties. (Counties interviewed are noted on Page 7.) Eighteen interviews were with County Commissioners, nine with County Administrators, ten were with County Engineers, ten with Road Superintendents, and one was with a County Clerk. One City Manager, five City Engineers/Public Works Directors and three Traffic Engineers were also interviewed.

County officials interviewed have responsibility for approximately twenty-one thousand miles of roadway, which includes over eighty-five hundred miles of unpaved roads and over twelve thousand miles of paved roads. These counties employ approximately nineteen-hundred persons in transportation related activities and consider themselves at least minimally equipped to fulfill their responsibilities. Approximately sixty-eight million dollars annually is reportedly expended on roadway related activities in the sampled counties. Additional funding is made available in some of the counties through the one-percent optional sales tax provision of Georgia Law.

Approximately ninety-five percent of all interviews indicated local officials to be generally familiar with the Technology Transfer Program. However, approximately thirty percent were not aware of the Technical Assistance and Technical Materials components of the program. The newsletter "TECH TRANS" is knowingly received in eighty-four percent of the agencies. The majority of recipients read, highlight and circulate the publication through the roadway organization. The workshop component constitutes the "flagship" of the program and is also well received throughout the State. While not specifically inventoried, it is perceived by the author that for many of those counties interested in upgrading their activities, these workshops are the only formal training opportunities reasonably available. The positive impact of the workshops on the employees selected to attend was mentioned on several occasions.

Recommendations for improvement of $T^2$ components were minimal. The newsletter is generally considered excellent with a few indications that more articles on local experiences would enhance the program. Other suggestions were for more information on specific subjects such as herbicides, materials, and equipment. Technical Assistance and Technical Materials components are utilized almost
exclusively by the more sophisticated operations. The particularly rural counties were generally not aware of these services. All workshops have been well received and appreciated. Several officials commented on over sophistication and suggested that workshops emphasize the "basics." On the other hand, the more urban counties usually suggested workshops of a more complex, comprehensive nature.

Innovative ideas relating to the program were relatively few. The most popular suggestion was to hold short, subject specific workshops at the county level. The rural counties in particular have problems in releasing their supervisory personnel for training, as such absence usually results in significantly decreased productivity. Another suggestion articulated by four of the more progressive respondees was for the Center to serve as focal point for a "brainstorming" activity on certain subjects, such as County Needs, Public Works Standards, and Quality Measuring Techniques, etc.

Charging attendance fees for workshops elicited mixed response. As would be expected, the majority indicated a willingness to pay. There was some concern regarding the amount charged, as the University of Georgia has traditionally worked with a ten to fifteen dollar fee structure. One county recently cancelled five attendees when advised of the fifty dollar per person fee and several others indicated that the fee structure would affect attendance or number of attendees. Unfortunately, the greater reluctance to pay is directly related to the more rural counties, which have the greatest need. In recognition of this need, one official suggested the possibility of providing "one free slot" for each governmental entity, with the established fee structure to be applicable to additional registrations.
INTRODUCTION

The Georgia Institute of Technology's Technology Transfer (T²) Center was one of the first Centers formed in response to FHWA Rural Transportation Program's (RTAP) 1982 solicitation for proposals for establishment of T² Centers. Georgia's submission was approved by FHWA and the Georgia Department of Transportation (GDOT), the organizational structure was firmed up and the program got under way in January 1983. Direction of the program was provided by a Policy Advisory Committee, which has been somewhat modified and expanded over time. Presently the committee consists of several representatives from GDOT, FHWA's Division Administrator, FHWA's County Advisor, a representative of the Association County Commissioners, a representative of the Georgia Municipal Association, a representative of the Georgia Institute of Technology and the membership of the Technical Advisory Committee. Day to day activities were, and continue to be, guided by the Technical Advisory Committee, which consists of technical representation from GDOT, FHWA, and Georgia Tech.

Actual operational responsibility for the T² Program was assigned to the Center's Director, M. John Moskaluk of Georgia Tech. Under his direction, the Center has continued to pursue the established objectives of the program. These objectives are: publication of a quarterly newsletter, provide technical assistance as requested, provide technical materials as requested, and develop and present technical workshops to meet the needs of local governments. To date, Georgia's T² Program has been successful and all objectives have been and are being met.

METHODOLOGY

In late 1987, it was determined that an evaluation of the T² Center's program should be made, and that such an evaluation should incorporate the users' views. Accordingly, by Agreement dated November 16, 1987, this consultant was engaged to visit and interview an unspecified number of local governmental officials. The Consultant's objective was to determine the general effectiveness of the program and to develop general recommendations for the continuation of the program. Specifically, the Agreement assigned three tasks as follows:

Task 1 Evaluate and Expand Awareness of the Center
Task 2 Assess the Needs of Local Agencies
Task 3  Prepare a Final Report

To accomplish the objectives of this effort and to fulfill the tasks adequately within the fiscal restraints, it was determined that a minimum of five interviews would be made in each State District except in District Seven. No interviews were conducted in District Seven because of a previous agreement that the $T^2$ Center should minimize its efforts in this District due to its predominately urban nature. Selection of those interviewed would be consistent with minimum travel times and distances with no particular attention given to a population/density stratification, budgetary considerations, or urban/rural configuration. It is obvious that any or all of these factors can have some influence in a highly scientific study. However, as the effort was more oriented to generalized perceptions, unstudied responses, estimated numbers, and opinions, it was concluded that such precise sampling techniques would constitute unwarranted effort and would be an unnecessary use of both time and fiscal resources.

The original concept was that each meeting would be arranged in advance with a specific person at a specific place and time. However, after an initial trial effort, during which it was found that such a procedure would not lend itself to efficient use of either time or travel, the meetings were arranged by simple telephone notification, advising that our representative would be at the interviewee's office at a specific time to discuss Technology Transfer. While some "misses" were expected and did occur, at least the interviewer was enroute to an adjacent county; and often when a "miss" occurred, someone else was available for discussion. On numerous occasions, the targeted individual did not feel that he/she was the proper person to respond to the various questions. In such instances, efforts were made to contact the "appropriate" person. However, if such person could not be located or if time constraints dictated, the interview with that particular agency was simply omitted. In all such instances, opportunity was taken to advise the individual(s) of the $T^2$ Program and encourage their calling upon the Center when or if assistance was needed.

Interviews were conducted on the basis of a previously prepared questionnaire (Appendix A). A detailed summary of questionnaire responses is contained in Appendix B, and the completed questionnaires are contained in Appendix C, which is submitted under separate cover. Special effort was made to adhere strictly to the questionnaire during the initial portion of the interview, so as not to bias responses. However, once the questionnaire was completed, opportunity was taken to elaborate on
the services available through the Center and to encourage the agency to take advantage of the offerings.

It should be recognized that the selected approach generally caught the interviewee cold, and generally was an interruption into an already busy schedule. On numerous occasions, the interview fell within some on-going activity. Accordingly, some responses were rushed, off the cuff, and not well studied or thought through.
FINDINGS

As previously indicated, interviews were conducted with fifty-seven county and city officials serving in capacities as follows:

<table>
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<th>POSITION</th>
<th>NUMBER</th>
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<td>County Commissioners</td>
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<tr>
<td>County Administrators</td>
<td>9</td>
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<td>County Engineers</td>
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<td>City Engineers/Public Works Directors</td>
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<td>Traffic Engineers</td>
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<tr>
<td>TOTAL</td>
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Approximately twenty-five additional officials were contacted but declined to be interviewed as they considered themselves to be the inappropriate person to discuss the technology transfer programs. These individuals were considered prime candidates upon which to expand awareness of the Center, and maximum use was made of the opportunities. (See Figure 1 for the statewide distribution of interviews.)

The above listed officials generally have responsibility for construction and maintenance of roadway systems within their jurisdiction. The State Highway System is, of course, excluded as GDOT accepts full responsibility for its construction and maintenance. Below are listed the mileages of the governmental entities interviewed as compared to Statewide totals:

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<td>Paved</td>
<td>Total</td>
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While a total of approximately 1900 employees are engaged in roadway related activities in the counties interviewed, the majority of respondees considered themselves understaffed for performance of their responsibilities. Equipment was considered only minimal for their program. However, there is not a consistency in local agency activity. Interviews indicated a broad range of activity; thus, the acknowledged level of responsibility extended from a grader/dump truck operation, basically accepting responsibility for only grading dirt roads and patching potholes, all the way to a sophisticated operation
including activities such as an asphalt plant, spreaders, and heavy construction equipment. Other counties maintain existing facilities and grade and drain new facilities, but look to GDOT for paving capability. Obviously, development of a T^2 Program to provide training services over such a wide spectrum of existing proficiency is indeed challenging.

Each of the Center's activities, i.e., Newsletter, Technical Assistance and Technical Materials, and Workshops is discussed below.

Newsletter

The newsletter, "TECH TRANS", is received by forty-eight of the fifty-seven officials interviewed. Nine officials did not receive personally, but generally indicated confidence that a copy came to their organization. Thirty-seven recipients read and circulated the newsletter to their staff, while eleven file their copy for future reference.

Twenty-nine respondees indicated that the document was excellent and that the hints, ideas and reminders made it very interesting and valuable to them. Two indicated that a principal value was in notification of availability of traffic counters, video tapes and other technical materials. Others commented on excellent articles on such topics as herbicides, equipment, and new research. The announcements and reminders regarding upcoming activities was also noted as an important feature. A total of forty-one officials indicated "TECH TRANS" to be of significant value to their agency.

Thirty-eight officials indicated the newsletter should not be modified. Three suggested that emphasis be placed on the basics, as the rural counties were in greater need. Others asked for more information on herbicides and traffic engineering. One asked for more technical content and another suggested the articles be given a summary caption to catch attention. Overall response to the newsletter was very favorable with an enthusiastic request for more of the same.

Technical Assistance and Technical Materials

As indicated in previous reports, a large number of the governmental officials interviewed were not aware of technical assistance and technical materials components of the program. Of the fifty-seven
interviews conducted, seventeen respondees indicated that they were "not aware," ten indicated "no need for these services to date" and nine indicated "rely on State." Based on informal discussions subsequent to the interviews, it appears that in reality, practically all interviewees fall into the "rely on State" category, at least to some extent. GDOT is to be commended for the excellent quality of service provided. While a few officials commented that GDOT's response time had increased over the last few years, all were very appreciative of the excellent quality of services rendered. As determined in the initial stages of the T program in Georgia, the Center's role in Technical Assistance and Technical Materials should be to augment, supplement, and possibly expand the availability of the services. The Department's personnel are perceived as local folks, who are approachable and capable, and they are already intimately familiar with many of the problems. Certainly, no changes should be considered.

This is not to imply that the Center's efforts in these activity areas are not fruitful. Ten interviewees indicated past usage of both services and all users indicated total satisfaction with the Center's response. Technical assistance and materials were requested and furnished in such subject areas as Bridges, Traffic Counting, Computers, Surface Treatment, Traffic Engineering, Guardrail, Videos, and School Crossing Warrants. Several additional respondees indicated intent to pursue certain operational problems with the Center, as time and work load permitted. It was noted that in almost all instances wherein the Center has been approached, the user was a professional engineering type. One respondee commented that the non-professional would be more reluctant to call on an "unknown" when a "known" was available. The Center's Technical Assistance and Materials components are providing much needed service at the local level and should continue to respond as appropriate upon request.

Comments relating to improving these services were few, as the users were well pleased with past performance, and the non-users were totally satisfied with existing arrangements. However, some observations were made that the Center needed to become better known. Local officials can relate and identify much better with an individual or individuals than with an institution. Periodic visitation at county level would be desired. However, recognizing staff and fiscal limitations, an interim approach suggested by several County Commissioners would be periodic attendance at County Administrators' meetings and Area Planning and Development Commissions (APDC) Board meetings. Assurances were given that periodic presentations by Center staff would be welcomed and appreciated. However, care should be taken, as too much "horn tooting" could create a demand exceeding the Center's capability to respond.
Workshops

The workshop component of the program is the most recognized activity of the 1st program. Forty-eight of the fifty-seven respondees had previously attended one or more workshops. On the whole they considered this effort excellent. The only adverse comments on the workshop component were:

*"Some portions were too technically oriented."
*"Some portions were too basic."
*"Need more hands-on training."

A suggestion offered on twenty-two occasions advocated augmentation of the program with establishment of a "tailgate" presentation concept. Particularly in the smaller rural counties, it is difficult to release supervisory personnel to attend a one or two day workshop due to the resulting decrease in productivity. In contrast, the County Commissioners involved indicated a strong willingness to pull in the entire road crew for a two to four hour subject specific course that could be immediately applied. The Center is encouraged to pursue this concept.

Specific results of the interviews as they apply to workshops are discussed in the following paragraphs.

Forty-eight of the interviewees indicated that they had attended workshops. Only nine indicated that they had not attended. Generally, these individuals were top administrative officials. Forty-nine indicated that others in their organization had attended, and the same number indicated that the workshops had been of value to them. Comments on the workshops were very positive with eleven individuals indicating that such activities have improved both quality and quantity of work performed. Others commented that attendance and association with peers enhanced the self-perception of those who attended. This direct association resulted in increased pride in work performance. Four indicated that this was the only available way for most counties to get formal training. Several commented on the merits of specific workshops such as Tort Liability, Roadway Maintenance, and Right-of-Way Acquisition. Specific comments are: "we have re-evaluated our program in view of potential liability;" "we have begun a roadway evaluation program;" "the county has started a herbicide program;" "our bridge repair program has greatly improved;" and "the county is undertaking a plant mix program on our own."
Forty-four respondees indicated that locations for workshops have been good. Forty-five considered the frequency and size to be good to excellent, and forty-five indicated that the subject material of past workshops was good to excellent. The remainder either could not respond due to non-attendance or indicated that such workshops would be more effective at the county level.

Numerous suggestions were made as to workshop subjects that would be of value to their agencies. The subjects are listed in descending order of frequency of response. The number of times suggested is given in the brackets, ( ).

Safety (13)
Flagmen Certification (11)
MUTCD (11)
Basics (Patching, ditch pulling, sealing, etc.) (9)
Herbicides (9)
Preventive Maintenance (9)
Tort Liability (9)
Equipment Operators’ Training (7)
Drainage (5)
Public Relations (4)
Right-of-way Acquisition (4)
Roadway Maintenance (4)
Bridge Inspection and Maintenance (3)
Bridges—Wood (3)
Construction and Maintenance—City Oriented (3)
Computer Training (3)
Storm Water Management (3)
Utilities (3)
Field Demonstrations (2)
Guardrail Installation (2)
Life-cycle Analysis—Equipment and Roadway (2)
Master Plan Development (2)
Patching (2)
Soil Erosion and Sediment Control (2)
Subdivision Regulations and Enforcement (2)
Supervisory Training (2)
Asphalt Plant Inspection (1)
Bridge Construction (simplified for counties) (1)
County Standards (1)
Estimating Procedures (1)
Planning Workshop (1)
Railroad Crossing Warrants (1)
Roadside Vegetation Management (1)
Roadway Inventory Procedures (1)
Soil Compaction Testing (1)
Soil Stabilization (1)
State/Local Interaction (1)
Street Lighting (1)
Surveying (1)
Traffic Analysis (1)
Traffic Control (1)
Traffic Engineering (1)
Zoning Ordinances and Enforcement (1)
Obviously, the above list can be consolidated or compressed into a more manageable one; however, in developing specific workshops, the detailed list may be of value in the formulation of future workshops. Based on results of the interviews, it appears that priority efforts for the workshop program should address Safety, Flagmen Certification, MUTCD, Basics, Herbicides, Preventive Maintenance, Tort Liability, and Equipment Operators Training.

**Selected General Subjects**

In response to locals being aware of and familiar with the T^2 Program and the respective roles of Federal, State, and the T^2 Center, fifty officials indicated that they were and seven either were not aware or would not respond.

Forty individuals had no suggestions regarding improvement of the Program. Ten reiterated their previous suggestion for augmentation of the program with more localized, subject specific, short courses or workshops. Two indicated that more personal exposure of T^2 Center staff would be worthwhile, and five either could not or did not respond.

Ranking of the four program components in order of importance, by thirty-seven respondees, was 1) Workshops (W), 2) Newsletters (N), 3) Technical Assistance (A), and 4) Technical Materials (M), with the last two being almost equal in relative importance. Nine officials ranked the components as WNMA, three ranked as WANM, and a single respondee suggested WMAN. Seven did not respond.

Regarding suggestions for evaluation or measurement of the Program's value to the local agencies, a single respondee estimated a three to five percent improvement in the productivity of his agency, but the remainder had no quantitative methodology to offer.

Fifty-two local officials could advise of no neglected activity areas in which the Center could or should be involved. The remainder offered the following comments:

Need on-site training in basic construction and maintenance activities (patching, surface treatment, ditch pulling, etc.).

T^2 Center could advise locals of any regulations that would affect their operations.

Need help in use of local materials used in construction. Also need assistance in sub-division control.

Provide information on new materials and concepts.
Set up "Job Register" of qualified Road Superintendents and foremen available for employment.

Video lectures and selected classroom presentations at Georgia Tech for use by locals.

Work with Area Planning and Development Commissions on selected presentations.

Provide more localized training opportunities in addition to the on-going program.

Based on the interviews as previously described and the response by local officials, recommendations for consideration in future T² Program activities are as follows in the next section.

RECOMMENDATIONS

In the newsletter, consideration should be given to incorporating more articles on Georgia's local procedures, practices or processes. Recognizing that this has been done from time to time, it is perceived that such reports have vastly more credence than similar activities reported from other states. Obviously, staff time would be required. One representative example is the cooperation among five counties to jointly purchase a hydro-seeder to solve their individual erosion problems. None of the counties could afford the purchase price of a hydro-seeder, consequently, the five counties jointly purchased a machine and jointly pay a full time operator. Presently, each county furnishes its own materials, however, they are exploring the possibility of bulk purchasing. Another example of this type in the cooperation among counties is the joint use of a pug-mill for cold-mix preparation in North Georgia. Possibly articles of this type would encourage joint participation by other counties.

Consideration should be given to the Center serving as focal point to bring together appropriate selected representation to "brainstorm" selected subjects. Recommended subjects as suggested by county officials to date are: County Needs, Public Works Standards, and Quality Measuring Techniques. However, the concept could be applied to a limitless number of additional subjects.

The fee structure assessed for workshop attendance should receive further consideration. It is perceived by some officials as being counter productive, as it may preclude attendance by the more rural counties, the very clients that are most in need of the Center's services. "One free slot" per agency was suggested by only one interviewee, but warrants serious consideration. While this matter was not specifically surveyed, several local officials commented that the fee structure would affect attendance or
number of attendees. Also, the $50 fees are high in comparison with the traditional $10/$15 charged by
the University of Georgia for governmental courses.

Consideration should be given to a Center representative attending County Administrators
Meetings and APDC Board Meetings at least annually.

The Center should consider encouraging local governments to use standard State specifications
with the Center serving as distributor and interpreter.

Consideration should be given to the Center becoming the repository for standard plans and
products and materials evaluations.

Consider a periodic publication listing published material and visual aids available from the
Center. A brief description of content of visual aids should be included.

Consider implementation of the "tail gate" concept training format. The shorter subject specific
workshops given at local level should receive wide support, especially from the more rural counties.

Consider on-site training opportunities utilizing existing county forces. For example, a field
lecture and field demonstration on pot-hole patching, or an on-site demonstration of proper crown
shaping and ditch pulling would be more meaningful than a classroom description.

Recommend that the Center assume the role of keeping locals advised of State and Federal
regulations that may affect local governments. Also, the Center could periodically remind counties of
their specific responsibilities with respect to a regulation or policy. An example is the relatively recent
Flagmen Certification requirements that apply to work on the State Highway System. Some counties
were not aware of these requirements even though they perform some duties on or adjacent to the State
Highways; i.e., driveway cuts.

Recommend exploration of the feasibility of video-taping lectures and selected classroom
presentations for use by local agencies.

Recommend formulation and presentation of workshops generally in the subject areas as
suggested by local officials.

Recommend for long range consideration that the Center, together with supporting agencies,
encourage legislative enactment of a Professional Engineering Law, which encourages, if not mandates,
the employment of professional expertise. It is felt by the author that, in conjunction with the purpose of
the T² program, local governments' existing resources could be more effectively and efficiently applied with professional guidance.

In future evaluation efforts, consideration should be given to the use of a more thorough interview process, i.e., early discussion session followed at a later date by a detailed interview.
APPENDIX A
Blank Questionnaire
TECHNOLOGY TRANSFER DATA SHEET

NAME ___________________________________ DATE ___________
TITLE ___________________________________
AGENCY ___________________________________ PHONE ___________
ADDRESS ___________________________________

BACKGROUND INFORMATION ON AGENCY

- NUMBER OF AGENCY PERSONNEL ___________
- NUMBER OF TRANSPORTATION PERSONNEL _______

<table>
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<th>Position/Title</th>
<th>Classification</th>
<th>Experience (yrs)</th>
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</table>

Available Equipment

Roadway Mileage

Public Transportation  Yes ___ No ___
Number of Buses

Annual Agency Budget
Annual Transportation Budget

EXPERIENCE WITH TECHNOLOGY TRANSFER PROGRAM

GENERAL KNOWLEDGE
Do you receive the Tech Trans?  Yes ___ No ___

Disposal or use

Has the Newsletter been of value to you or your agency? Describe.

How could the Newsletter be modified to be of more value?

Further comments—
TECHNICAL ASSISTANCE

Have you utilized the Technical Assistance component of the program? Yes ____ No ____

Describe-

Has this service been of value?

How can this service element be improved?

Further comments-
TECHNICAL MATERIALS

Have you or your agency used the Technical Materials component of the program? Yes ___ No ___

What materials have you requested? Received ___ Not ___

How can this service of the program be improved?

Further comment-
TRAINING (WORKSHOPS)

Have you participated in Technology Transfer workshops? Yes ____ No ____

Have others in your agency participated? Yes ____ No ____
Who?

Have the workshops been of value to you and your agency? Yes ____ No ____
Describe-

Based on your experience, what are your comments or recommendations regarding:

Workshop location-

Frequency, size and/or location-

Subject Material-

Other subject areas for workshops you consider important--

Your suggestions for revised format to better serve your agency--
GENERAL SUBJECT AREAS FOR DISCUSSION WITH SELECTED INDIVIDUALS AS APPROPRIATE

1. Technology Transfer Program -- are locals aware and familiar with the program? Also, the roles of Federal, State, and T2 Center?

2. Innovative ideas relating to improvement of the Program and its ability to provide needed services.

3. The local feeling regarding the Program and the relative importance of the four services (Newsletters, Assistance, Materials, and Workshops) being provided.

4. Suggestions regarding evaluation or measurement of the Program's values to the locals.

5. Neglected activity areas in which the center could or should be involved.

6. The need for locals to react to the Program. The Federal, State, and the Center needs local response to the specifics of the Program.
APPENDIX B
Summary of Questionnaire Data
SUMMARY OF QUESTIONNAIRE DATA

General Interview Data

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<td>Interviews conducted</td>
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<tr>
<td>County personnel</td>
<td>48</td>
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<td>Others (city and city/county)</td>
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<tr>
<td>Counties surveyed</td>
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Agency Background Data

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<tr>
<td>Transportation personnel in respondees' counties</td>
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<tr>
<td>Counties' roadway mileage</td>
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<tr>
<td>Paved</td>
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<td>Unpaved</td>
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<td>Public transportation systems within counties</td>
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<td>Annual average roadway budget in respondees' counties</td>
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Technology Transfer Program Data

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<td>Generally knowledgeable of T³ Program</td>
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<td>Receives TECH TRANS newsletter</td>
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<td>Retains TECH TRANS for personal use</td>
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<td>Circulates or passes on</td>
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<td>No suggestions for modification of TECH TRANS</td>
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<td>Suggestions for TECH TRANS</td>
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<tr>
<td>Use Technical Assistance and Materials (TA&amp;M)</td>
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<td>Agencies that &quot;rely on state&quot; for TA&amp;M</td>
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<td>&quot;No need for&quot; TA&amp;M</td>
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<td>Workshops of value to agency</td>
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<td>Workshop locations good to excellent</td>
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<tr>
<td>Recommend local workshops</td>
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<td>Frequency and size good to excellent</td>
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<tr>
<td>Subject materials good to excellent</td>
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<tr>
<td>Existing format good to excellent</td>
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Response to Specific Subject Areas

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<tr>
<td>Knowledgeable of program and Federal, State, and T³ Center's roles</td>
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<tr>
<td>Not familiar</td>
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<td>Innovative ideas relating to program:</td>
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<tr>
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<td>Further comment on need for some local orientation</td>
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<td>Center needs more exposure</td>
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<tr>
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<td>Ranking by relative importance of program components— Newsletter (N), Technical Assistance (A), Technical Materials (M), and Workshops (W)</td>
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<tr>
<td>---------------------------------------------------------------</td>
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<tr>
<td>WNAM</td>
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<td>WMAN</td>
<td>1</td>
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<tr>
<td>No response</td>
<td>7</td>
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Neglected activities Center should undertake:
- Specific recommendation (included in report) | 5 |
- No suggestions | 52 |

Need for active response to program:
- Recognize or understand | 55 |
- No response | 2 |
APPENDIX C
Completed Questionnaires

Note: These questionnaires were submitted previously under separate cover to GDOT, Office of Materials Research.
APPENDIX D
Evaluation Questionnaire Summary

Note: Appendix D summarizes a GDOT Technology Transfer Center Evaluation Questionnaire prepared and conducted subsequent to preparation of this report. The response was unquestionably excellent and provides considerable additional high quality data relating to the Technology Transfer Program.
I have received completed questionnaires from 76 counties for a 48% return. Responses were also received from 11 cities. Of the 87 responses, 66 want the program to continue, 10 are neutral, and 11 do not want the program to continue. A county outline map is attached showing the responses for all counties except four which were unknown. We were looking for any pattern which might show up, but none was found. A distribution of responses by county population is included as Attachment 2. Eighteen of the 22 most populous counties (greater than 50,000) responded with 17 of the 18 wanting the program to continue. Responses dropped as population decreased with a higher proportion of these counties having less interest in the program.

Attachment 3 is a copy of the questionnaire with responses totalled. Question 2 asks about any increase in productivity due to the Technology Transfer Program. Eleven responses showed a 10-15% increase, 24 a 5-9% increase, 25 a 1-4% increase, and only 5 indicating no increase in productivity.

The idea of conducting workshops at individual county shops was very popular. All 71 of those who completed the whole questionnaire indicated that they would be willing to attend a 2-hour workshop.

Attachment 4 is a summary of the programs counties would like to see and other general comments. They suggested a number of topics which will give the Technology Transfer Center ideas for new workshops. The most popular topics were bridges, pavement design and pavement maintenance. Under general comments, ten questionnaires specifically mentioned that workshops should be offered locally.

Attachment 5 is a summary of the questionnaires by county and is included for your information.
Legend:

- Counties that replied, YES - "program to continue", 66
- Counties neutral, reply blank, "program to continue", 10
- Counties that replied NO - "program to continue", 11

* question 4. in questionnaire, "Should the T² Center continue to provide services to cities and counties?"
## GDOT SUMMARY OF GA. TECH T\(^2\) CENTER EVALUATION QUESTIONNAIRE

### Counties, population > 50,000

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<th>Population</th>
<th>County</th>
<th>1980 Ranking</th>
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### Counties, population > 20,000

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</tbody>
</table>

### Legend:

- Counties that replied, YES - "program to continue"*, 66
- Counties neutral, reply blank, - "program to continue", 10
- Counties that replied NO - "program to continue", 11

*question 4. in questionnaire, "Should the T\(^2\) Center continue to provide services to cities and counties?"

Summarized by Research & Development Bureau, Office of Materials & Research

25 August 1988
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<th>Counties, population &gt; 10,000</th>
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ATTACHMENT 3

GDOT SUMMARY OF RESPONSE

GEORGIA TECH TECHNOLOGY TRANSFER CENTER
EVALUATION QUESTIONNAIRE

1. Has your jurisdiction used the services of the T² Center?

Yes  66
No  21

If No, why not?

____________________________________________________________________

If Yes, what services have you used?

55  Attended T² Workshops
58  Received and Read Newsletter
27  Received Publications and/or Technical Assistance.

2. Have the services of the T² Center been of value?

Yes  62
No  9

If No, why not?

____________________________________________________________________

If Yes, how have the services of the T² Center changed the Transportation related work productivity of your agency?

11  10-15% Increase in Productivity
24  5-9% Increase in Productivity
25  1-4% Increase in Productivity
 5  0% Little or No Increase in Productivity

3. Rank the services that have resulted in increased productivity. Put "0" if of no value.

53  Workshops
48  Newsletters
40  Publications
32  Assistance

Totals Only - See Attachment 5 for ranking
4. Should the T² Center continue to provide services to cities and counties?
   Yes 66
   No 11

5. If it continues, should the T² Center provide workshops that could be conducted at your shop?
   Yes 69
   No 11
   If Yes, would you be willing to send (allow) your Roadway Crew to attend a two-hour workshop?
   Yes 71
   No 0

6. What other topics or programs could be offered that would benefit you?

   See Attachment 4.
Summary of Counties' Responses on Question 6: "What other topics or programs could be offered that would benefit you?"

Information is listed alphabetically by subjects and the number of times mentioned by different counties so noted. General comments are presented at the end.

Bridges: Inspection (3); Maintenance (3); Repair (3), of wooden bridges (1)
Construction: Contract Administration; Supervision and Testing
Data Management/Computer Training
Drainage (2)
Equipment Maintenance (1), Heavy Equipment Maintenance (1)
Guardrail, including bridge approaches
Liability
Hydrology training
Mapping & CAD related to surveying
Pavement Design: Roadways (3), Streets (2) and Intersections; Rehabilitation Alternatives; CAD; Base Applications
Pavement Evaluation: Road Inventory systems; operations
Pavement Maintenance: Roads (4); Dirt Roads (4); and Dust Control
Potholes (2)
Risk Management
Right of Way, acquisition
Traffic Safety (2): Traffic Control; Flagging & Sealing Off Roads, Worksite Safety
Traffic Signs (2) and Signals & Sign Theft Prevention
Transportation: Design; Engineering
Utility Cuts and Repairs
Vegetation, Roadside: Establishment; Management (2); Mowing, Shoulders
Waste: Energy Programs; water applications to land

General Comments:
. Workshops should be offered locally (10)
. T² personnel need to be "in the field" for more personal help
. Workshops for maintenance and construction personnel
. Technical assistance is the most important service
. Public Works, the term, needs to be defined re normal and frequency
. T² needs better library for completed research on safety programs
. VCR training films need for local training classes (2)
. Publications/Information on GDOT accepted methods/materials
. System for sharing ideas/problems between counties of comparative size with similar problems
. Waive registration fees
. Comprehensive funding packages for improvements
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