

Idaho Division of Highways
Boise, Idaho

VALUE ENGINEERING
STUDY OF SHOULDER MAINTENANCE

Research Project 83

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This project was undertaken in cooperation with the U. S. Department of Transportation, Federal Highway Administration, and the State Highway agencies of Arizona, Iowa, and West Virginia. This report represents Idaho's input to the project. A final report summarizing the work of all four State study teams will be published by FHWA.

ACKNOWLEDGEMENTS

This report is Idaho's contribution to a cooperative study involving three other States and the U. S. Department of Transportation. Project participants attended one coordination meeting in each of the four States. At these meetings, the Idaho study team exchanged ideas and information with representatives from the other States, and it is to be expected that these contacts have had some influence on this report. The non-Idaho study team members were:

FHWA

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Information on shoulder maintenance procedures was furnished by the State highway agencies of Alabama, Florida, and Michigan in addition to that furnished by the direct participants in the study.

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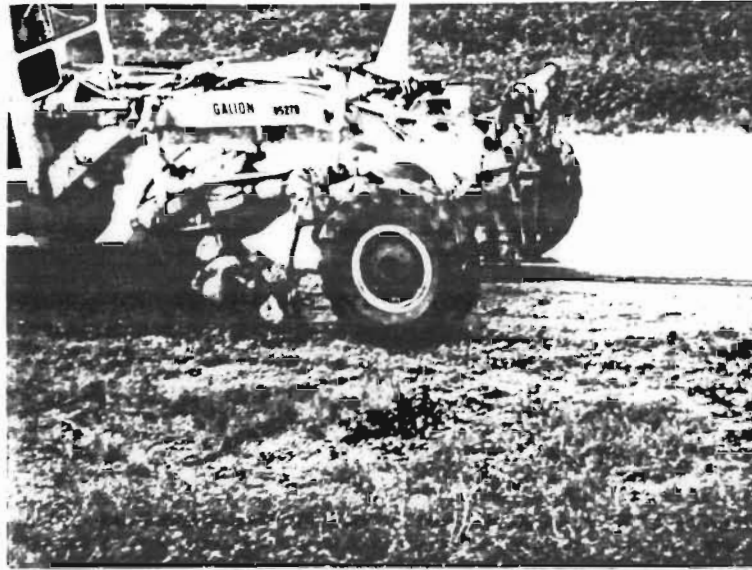
I

SUMMARY

This report is the result of a value engineering study of fore-slope (shoulder) maintenance in the Idaho Division of Highways. The work was done by a study team made up of the Research Supervisor, one District Engineer, two District Maintenance Engineers and the Associate Materials Engineer I. Concurrent studies of shoulder maintenance were made in Arizona, Iowa, and West Virginia, and one coordination meeting was held in each of the four States during the study period. The entire project was sponsored by the Federal Highway Administration. Estimated cost savings approaching 50% were identified in connection with foreslope reshaping for the idealized case where obstructions such as delineators and signposts could be removed. Estimated cost savings of up to 26% were identified in the foreslope reshaping operation without removal of fore-slope obstructions. A final report combining the results of all four State studies will be prepared by the Research Section under a contract with FHWA.

Major recommendations of the Idaho study involve equipment and procedural modifications for improvement of foreslope (shoulder) maintenance. A recommendation is made regarding development of an improved shoulder type selection process.

Foreslope Reshaping Without Adding Material:
Present Practice



Pulling Material Up Foreslope to Repair Dropoff:
Excess is Bladed Onto Pavement

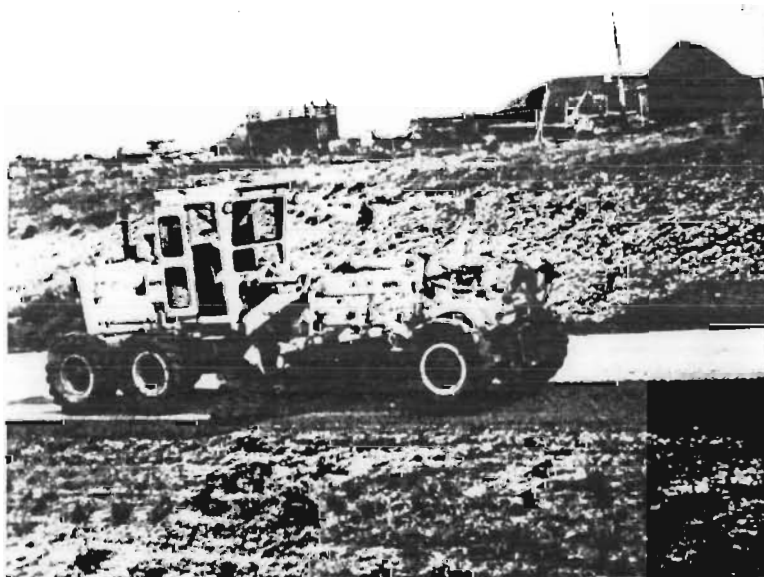


Removing Excess Material from Pavement
and Compacting with Rear Wheels of Grader

Foreslope Reshaping with Added Material:
Present Practice



Dumping on Pavement Surface



Blading Material off Pavement: A Second
Pass May be Needed to Smooth Foreslope and
Compact the Fresh Material in the Dropoff Area

II

RECOMMENDATIONS

1. The maintenance activity of reshaping the foreslope without adding material should be modified as follows:

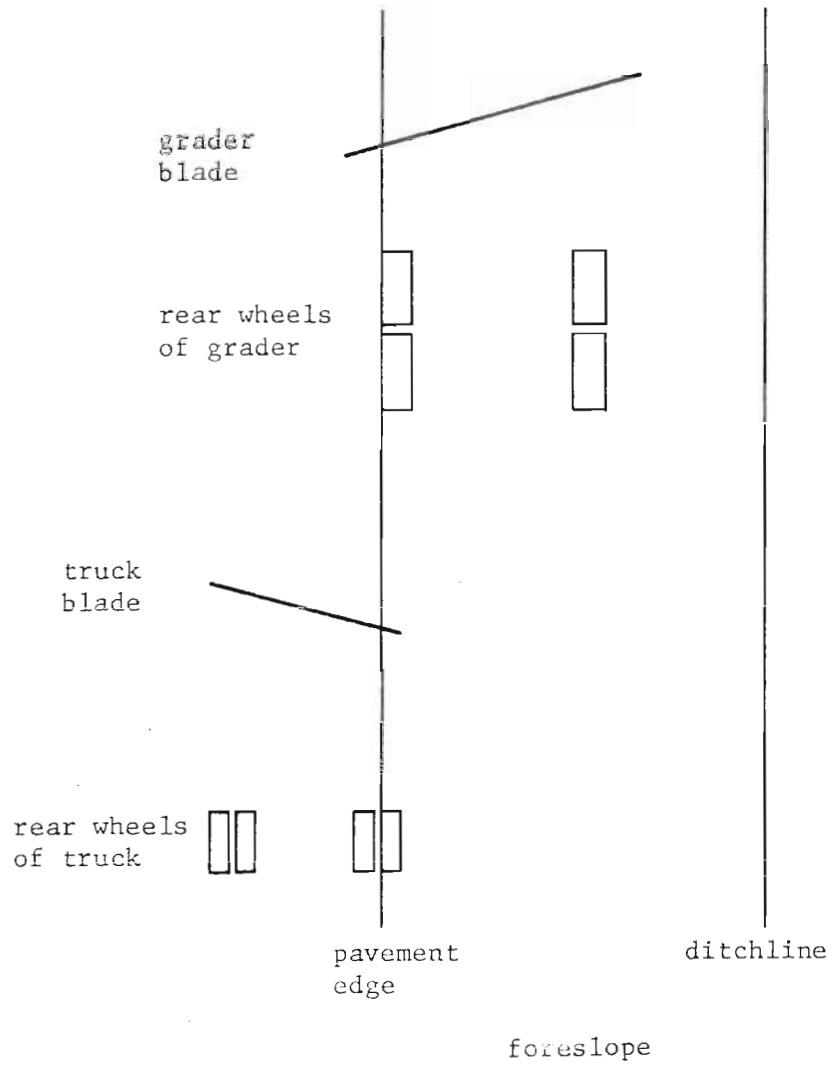
- A. Tandem operation of a grader and dump truck with blade should be tried. The grader would pull material up the foreslope, depositing the excess on the pavement edge. The truck would follow, blading the excess off the pavement and compacting the fresh material into the drop off with its rear wheels. (Diagram on page 5)

As an alternate to the truck-mounted blade, the use of an auxiliary blade mounted on the grader could be tried. It would be mounted at the rear of the machine and should be mounted in such a way that minimum operator attention is required during the reshaping operation. (Diagram on page 6)

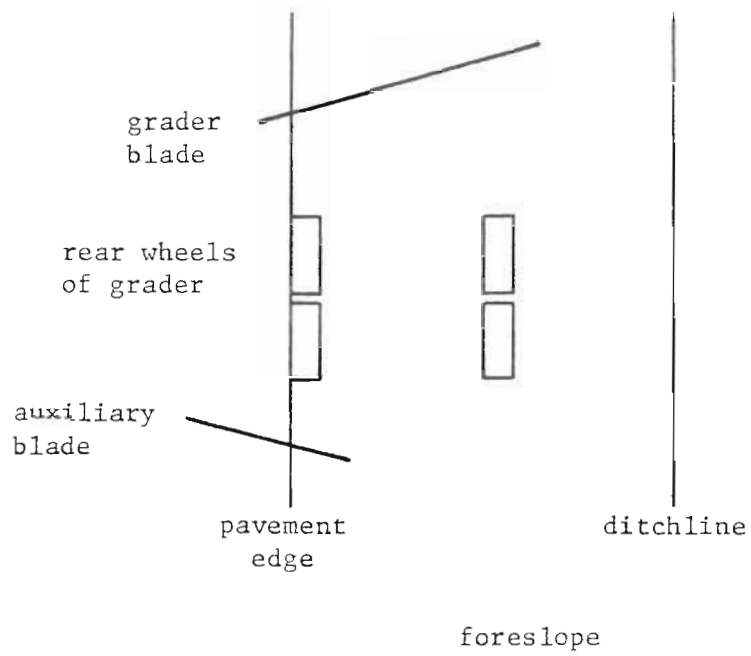
- B. In areas with few foreslope obstructions such as delineator posts, signposts, culvert headwalls, etc., a modified grader blade should be tried. Suggested modifications include the addition of an end plate and the use of lateral blade shift. The end plate would improve the control of material flow at the blade tip, enabling the operator to fill the edge drop off with very little spillover onto the pavement. Blade shift would permit compaction to be done on the same blade pass with edge rut filling. The blade might have to be shortened to eliminate interference with roadside obstacles. These modifications would eliminate one blade pass presently needed for removing material pulled onto the pavement on the initial grader pass. (Diagram on page 6)

2. The maintenance activity of reshaping the foreslope with added material should be modified by spreading the fresh material directly on the foreslope rather than dumping on the pavement and blading off. Because a standard dump truck is unstable when operated on the foreslope with its bed raised, equipment modification is needed. This might take the form of a side delivery spreader box towed by a dump truck on the pavement. A second possibility would be the use of a conveyor belt type of dump body with side delivery chute. (Diagram on page 7)
3. A systematic, rational procedure should be developed for determination of the appropriate shoulder type during roadway design.

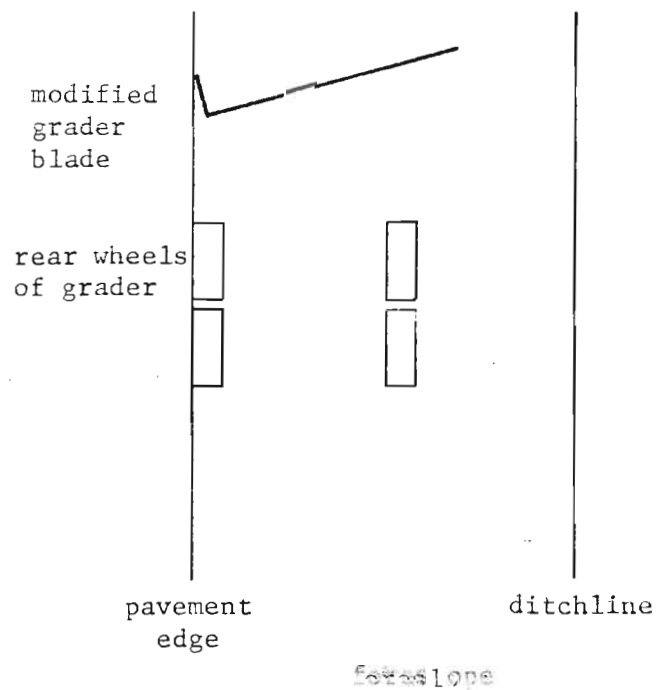
Schematic Diagram of Recommendation 1A



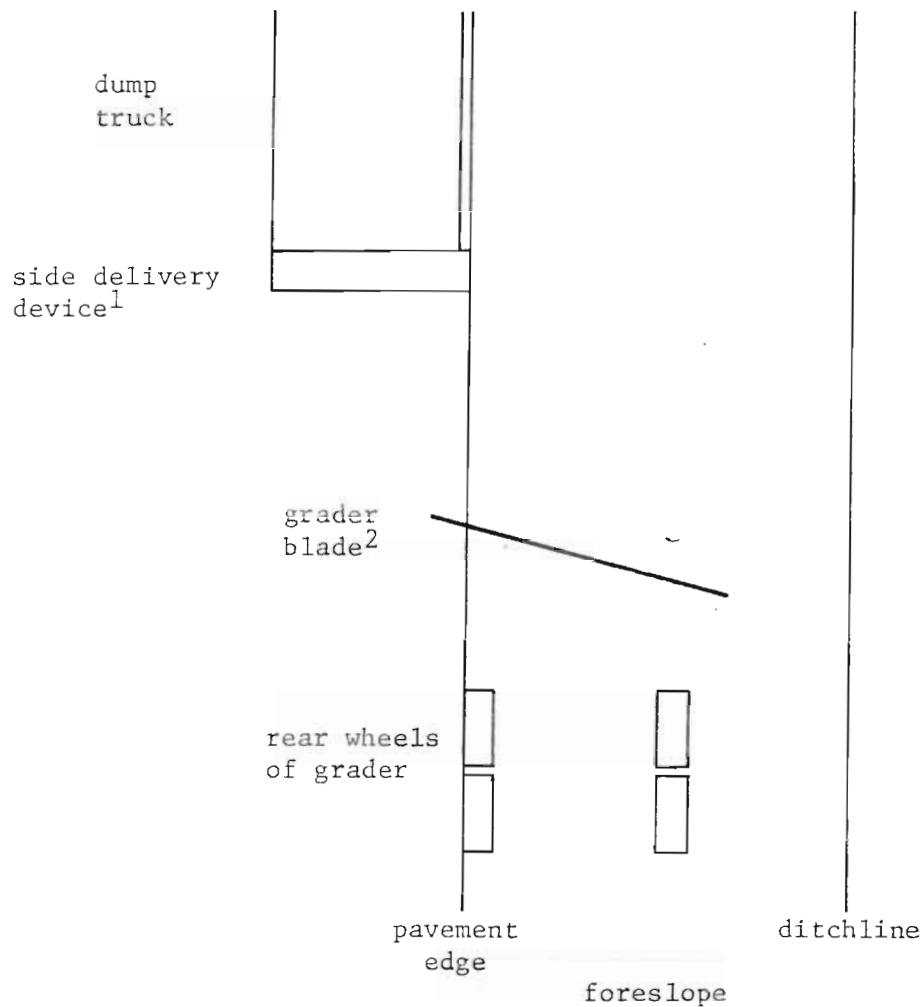
Schematic Diagram of Alternate Recommendation 1A



Schematic Diagram of Recommendation 1B



Schematic Diagram of Recommendation 2



- Notes:
1. This might be a side delivery chute for a conveyor-type dump bed. Other possibilities are a sidecasting tailgate attachment or a side delivery spreader for use with a regular dump bed.
 2. A strikeoff blade might be mounted on the spreader, eliminating the need for a grader to shape the new material. Compaction would be provided by driving the haul trucks over the repair as they approach the work site.

III

BACKGROUND

Objective

The objective of this project was to optimize the expenditure of shoulder maintenance resources, using value engineering techniques.

Scope

Idaho's value engineering team included four engineers with considerable experience in field operations. Districts 1 (Greene), 5 (Harding), and 6 (Gillespie) were represented directly. In addition, Mr. Hill has had considerable experience as Assistant District Engineer in District 4, so a wide range of Idaho conditions and experience was represented. The study procedures were those described in the FHWA publication Value Engineering for Highways.

The work included data collection to illustrate the operation of one maintenance station in each of three Districts (District 1, 5, 6). In addition, statewide costs were obtained and used in shoulder maintenance cost analyses. Selected shoulder maintenance operations were analyzed functionally in an effort to reduce their cost.

Limitations

Because of the limited time and other resources allocated for the study, it was not possible to evaluate all shoulder maintenance activities. Therefore, two of the most frequently performed activities were chosen for analysis: reshaping foreslope without adding material and reshaping foreslope with material added. Paved shoulder maintenance was eliminated from consideration because a separate FHWA sponsored project is planned on pavement patching.

IV

STUDY APPROACH

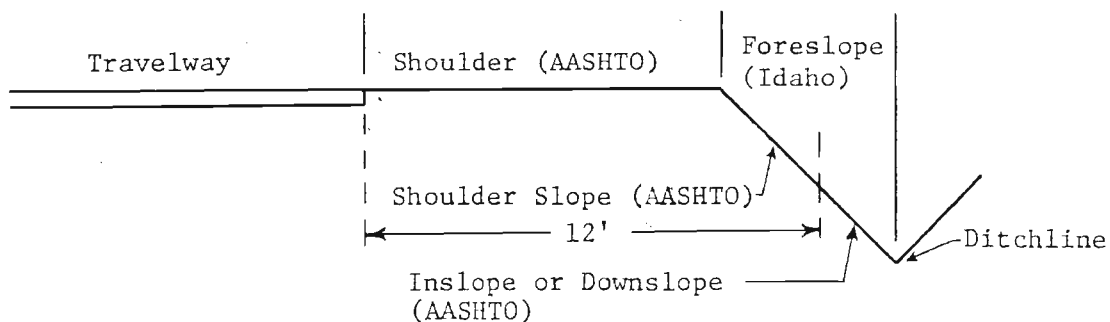
The overall study was sponsored and funded by the Federal Highway Administration (FHWA). The major part of each State's contribution to this overall study was a local study made over a period of about six months during 1976. All participants attended a series of four coordination meetings during the project. One such meeting was held in each of the participating States.

At the first joint meeting the principles of value engineering (VE) were discussed briefly. The discussion served as an introduction, but further individual study was needed to carry out the project.

A second topic discussed at the initial joint meeting was visual documentation of existing shoulder maintenance procedures, both to aid each State in its own study and to promote the interchange of ideas at subsequent joint meetings. FHWA made videotape equipment available for this purpose. The Idaho team used this equipment in District One and the team members were favorably impressed with the ease and effectiveness of videotape recording and presentation.

Two basic attitudes toward highway shoulder construction and maintenance were discussed at the first joint meeting. In Arizona and Idaho paved shoulders are standard on new construction whereas unpaved shoulders are standard in Iowa and West Virginia. Although a few sections of highway with unpaved shoulders exist in Idaho, a very high percentage of the total mileage has paved shoulders. Maintenance operations on paved shoulders are the same as pavement maintenance and the topic of pavement patching will be covered in a separate FHWA-sponsored VE study. Therefore, this study was limited to maintenance of the unpaved foreslope next to the pavement.

The two maintenance activities included in the study are foreslope reshaping and foreslope reshaping with material added. They are the same as maintenance operations on unpaved shoulders except for complications resulting from the steeper slope and obstructions such as delineator posts and other appurtenances on the foreslope.



Although the study emphasizes shoulder maintenance, considerable discussion took place on the more basic issue of shoulder design. This was a natural result of the fact that two of the States involved specify paved highway shoulders as standard practice, whereas unpaved shoulders are standard in the other two States for all roads except freeways. Because of the interest in the question of shoulder type, a portion of this study was devoted to economic analysis of paved vs. unpaved shoulders.

FINDINGS

Unit cost of shoulder pulling without adding material could be reduced by as much as 50% if interference with foreslope obstacles could be eliminated. The most numerous and easily relocated of these are delineator posts. Actual attainable cost savings would be somewhat less than 50% because even if delineators were removed or relocated, other obstacles such as signposts and culvert ends would remain. One equipment modification needed would be a grader blade wing plate or other device to improve operator control over material flow at the blade tip. This would permit the operator to fill the edge rut with very little spillover onto the pavement surface, thus eliminating the grader pass presently required for cleaning the pavement. Lateral blade shift and blade shortening might be required to permit compaction with the rear wheels of the grader and to minimize conflicts with roadside obstacles.

Unit cost of shoulder pulling without adding material could be reduced by as much as 26% with no change in delineation practice. This would require tandem operation of a grader followed by a dump truck with plow blade or stiff broom attached. The blade or broom might be attached to the truck either at the front or by an underbody mount. The grader would pull material up the slope, filling the edge rut and depositing the excess on the pavement edge. The dump truck would remove the excess from the pavement, compacting the strip next to the pavement with the rear truck wheels. The savings result from the fact that the rental rate for a dump truck with plow is less than half the rate for a medium size motor grader. Additional savings could be realized if a satisfactory auxiliary grader blade could be developed, thus eliminating the need for a second vehicle pass to remove excess material from the pavement.

Unit cost of shoulder pulling with material added might be reduced by 16% or more with improved traffic safety by depositing the material directly in the edge rut instead of dumping on the pavement and blading off the pavement to fill the edge rut. This estimate does not include the cost of some development work which would be needed. Equipment which might be adapted to the modified procedure includes conveyor belt dump truck bodies or side delivery spreaders for use with regular dump truck bodies.

In some instances, paved shoulders can be justified on the basis of maintenance savings alone. Even in cases where this is not true, other benefits may make paved shoulders attractive. Reliable data on some economic benefits is, however, not available.

VI

ECONOMIC CONSIDERATIONS

A primary goal of value engineering is cost reduction. Knowledge of existing costs is needed as a starting point in VE analysis. Unfortunately, determination of accurate Idaho costs was hindered by lack of detail in the maintenance accounting procedures. Maintenance cost estimates were, therefore, developed based on known costs for equipment rental, wages, fringe benefits, and construction materials. Cost per unit of accomplishment was estimated using the standard accomplishment rate given in the ITD Division of Highways Maintenance Operation Procedures Book. This accomplishment rate was developed by consultation among maintenance engineers and foremen statewide, based on their field experience. It may be revised when sufficient data is available under the new maintenance management system.

The estimated savings have been given as percentages rather than dollar amounts to avoid consideration of rapidly changing prices. Assuming prices and wages change at about the same rate in the long term, the percentages should remain representative even if dollar amounts change considerably.

An actual cash savings is not the only possible outcome of improved maintenance procedures. Instead, the reduced unit cost may mean that more units will be performed for a given amount of money. Either way, the result would be improved operation.

As mentioned elsewhere, implementation of the suggested changes will require some development work. Development costs are very difficult to estimate, but should be minimal in view of the fact that most of the suggested techniques are known to be workable. For example, the VE team observed the use of a homemade wing plate on a grader blade in District One. The wing helped the operator spread road mix to a predetermined edgeline with good accuracy. This technique should work reasonably well with aggregate also. Another example is the sidecasting spreader box developed by Iowa DOT specifically for edge rut filling. This machine is described more fully in the next section. A less elaborate device may be desirable for Idaho, but the Iowa equipment provides a workable starting point for further development if refinement is desired.

Although the original intent of the project was to consider maintenance alone, reasons for initial selection of a particular shoulder type were naturally discussed as a result of the differing practices among participating States. Shoulder type does have a large influence on overall shoulder maintenance cost because of the widely different maintenance requirements among various shoulder types. The decision as to shoulder type would be influenced by other factors, too. In many cases, the decision as to shoulder type will have to be made without complete economic analysis because of a lack of reliable economic data. Either way, a checklist of items requiring consideration would be helpful. Transportation Research Record 594 contains an excellent summary of the effects

of shoulder paving, prepared by J. M. Portigo of the Michigan Department of State Highways and Transportation. That summary would be helpful in formulating or updating a shoulder type selection policy.

VII

OBSERVATIONS

One of the valuable features of a cooperative study such as this is the chance to learn firsthand about the different ways other States have approached common problems. Idaho's team members were particularly impressed with two items of shoulder maintenance equipment developed by Iowa DOT. These are an edge rut filling device mounted on a dump truck and a light-duty shaping blade drawn by a small industrial tractor. The edge rut (drop off) filler is essentially a shallow side delivery hopper containing a conveyor belt. A dump truck dumps aggregate into the hopper and the belt deposits this material next to the pavement. Attached shaper blades smooth the material and remove spillage from the pavement. The tractor-drawn shaper is used to move material from the shoulder into the edge rut and for general smoothing of the shoulder surface. An auxiliary blade removes any material spread on the pavement by the primary blade. Regardless of whether this equipment would be practical for use in Idaho, seeing and discussing it with Iowa maintenance personnel has stimulated ideas for improvements in Idaho's shoulder maintenance.

Idaho has only limited experience in maintaining the longitudinal joint between PCC driving lanes and plant mix shoulders. Representatives of other States involved in this study discussed techniques they believe effective for minimizing problems associated with this joint. West Virginia has a test section in which the shoulders were paved with penetration Macadam rather than plant mix. Construction cost is reported to be competitive with plant mix and no joint separation or differential settlement has occurred over a period of several years. Iowa has used a modified asphalt slurry spreader which fills the open joint and places a one foot wide tapered wedge to smooth the drop-off caused by differential settlement. A method used in Arizona to minimize problems is to rout the joint to create a gap of at least 1/2 inch, then fill the gap with a mixture of rubber particles and asphalt.

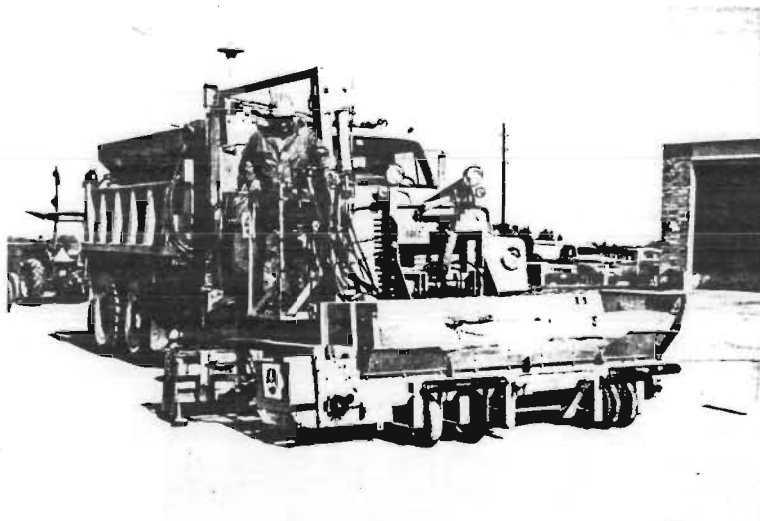
Discussions among the participants from various States covered many maintenance subjects other than shoulder repair techniques. The team members felt this was a valuable part of the project, resulting in the exchange of many interesting and useful ideas. Several of these will be summarized here.

One item which received considerable discussion is the maintenance management system. All four participating State agencies have adopted such systems, which are intended to improve management of the maintenance function. An essential component of any effective management system is feedback, or information returning from the managed function to indicate how well the function is being performed. Reports of work units and resources used to accomplish them constitute such feedback and are universal features of maintenance management systems. A feedback item not frequently measured quantitatively is the level of service being provided. Among the four study States, only Iowa has a formal procedure for estimating the degree of compliance with maintenance standards. This additional feedback

information helps managers judge the overall effectiveness of the maintenance program so they can make timely adjustments in standards, procedures, or resource allocation as needed. Unfortunately, maintenance standards are sometimes written in such a way that quantitative measurement of the degree of compliance is very difficult. This makes it difficult to ascertain the actual quality of service being provided. Quality of service is a topic recommended by TRB*for further research.

Several ideas for equipment modifications or special purpose maintenance equipment were exchanged. For example, Idaho's "Portorail" movable concrete median or edge barrier stimulated considerable interest among the study participants from the other three States. Each non-Idaho delegation was furnished a set of drawings for the barrier. The Arizona representatives described an air deflector or scoop made from a section of obsolete crescent-shaped metal guardrail. The deflector is mounted horizontally above the rear of a sander or snowplow truck to divert air downward, thus preventing snow buildup on the tail lights. This idea is now being tried in Idaho's District 5. Iowa's maintenance sign trailer is another example of a potentially useful special purpose equipment item. This is a small trailer which can be pulled to a work site by a dump truck or, if necessary, by a pickup. It carries up to eight folding signs and enough traffic cones for most maintenance operations. A flashing sign can be mounted above the trailer. This trailer improves the organization of traffic control and should also reduce sign damage during loading, travel, and unloading. Plans and photographs of Iowa's maintenance sign trailer were obtained by Idaho's team members. A second idea from Iowa DOT is a folding metal ladder permanently attached to the side of a dump truck or sander bed for safe access to the interior of the bed.

*Transportation Research Board



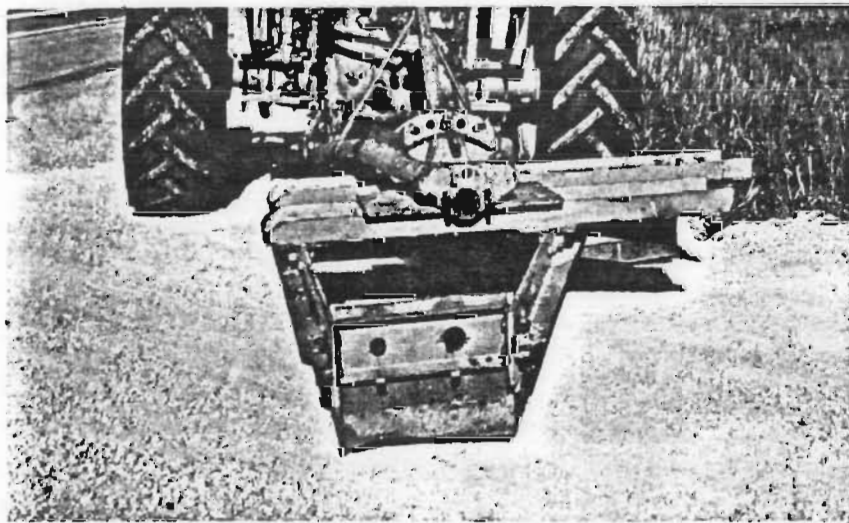
Iowa Edge Rut Repair Device



Iowa Edge Rut Repair Device in Operation



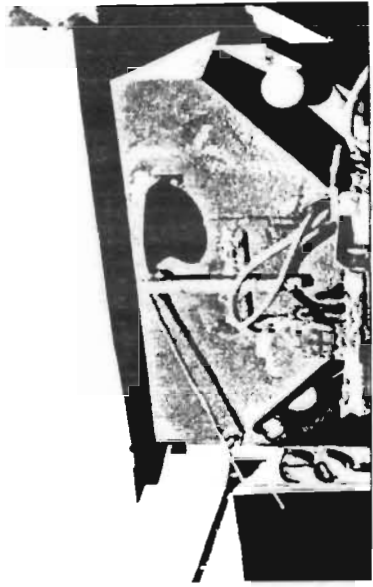
Iowa Light Duty Shoulder Reshaper



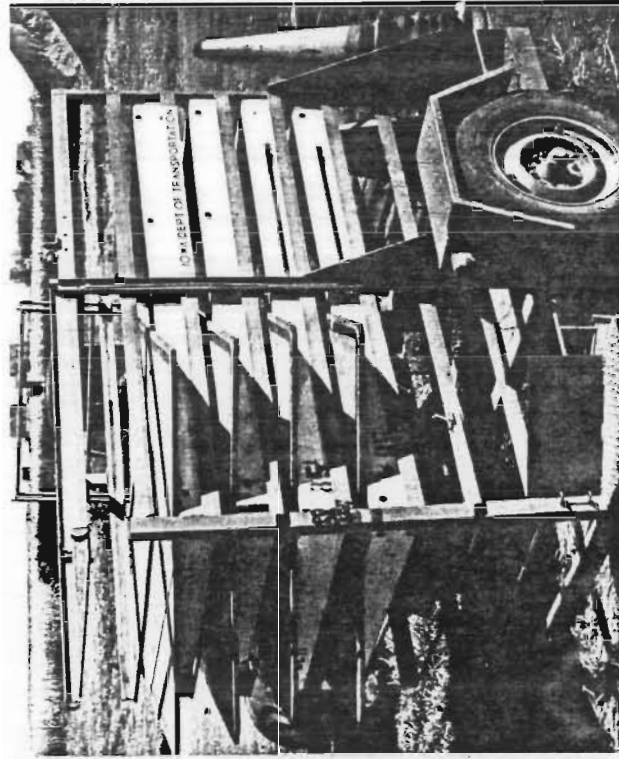
Iowa Light Duty Shoulder Reshaper



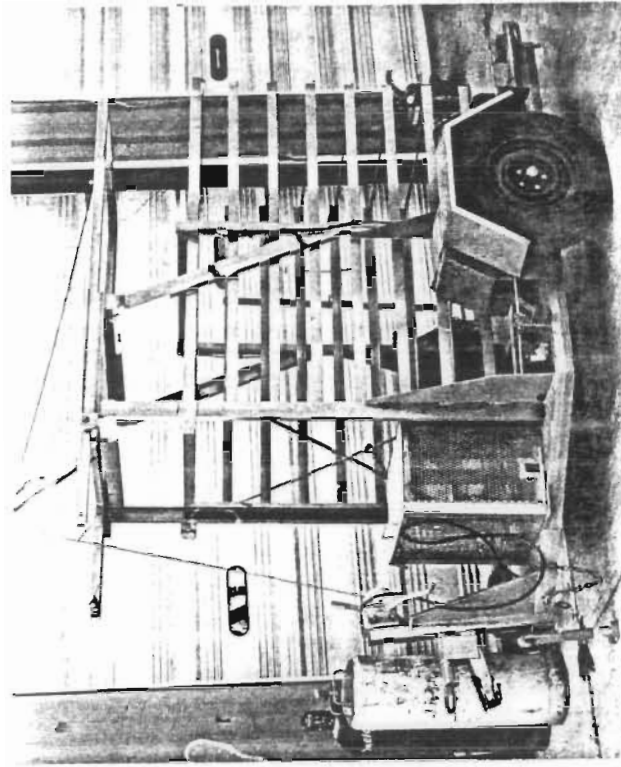
Arizona Air Deflector



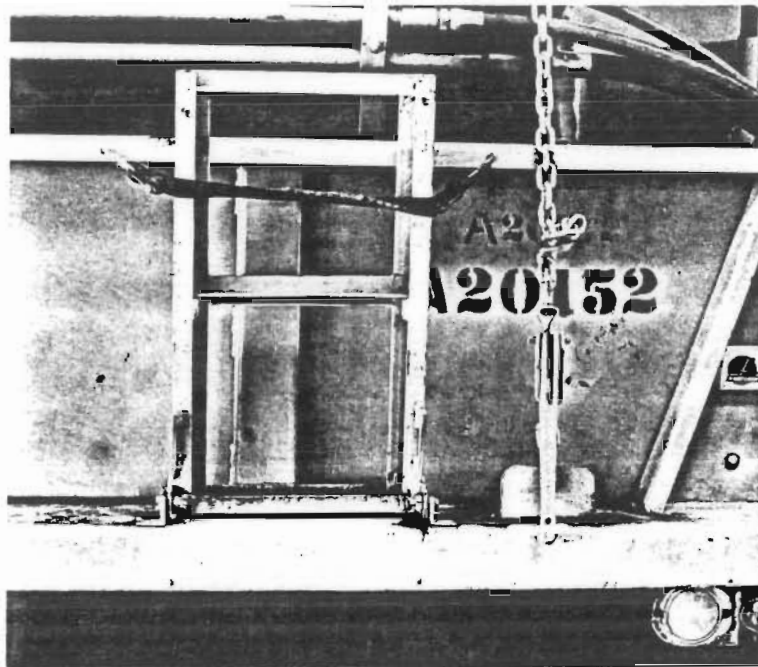
Arizona Air Deflector on Sanding Truck



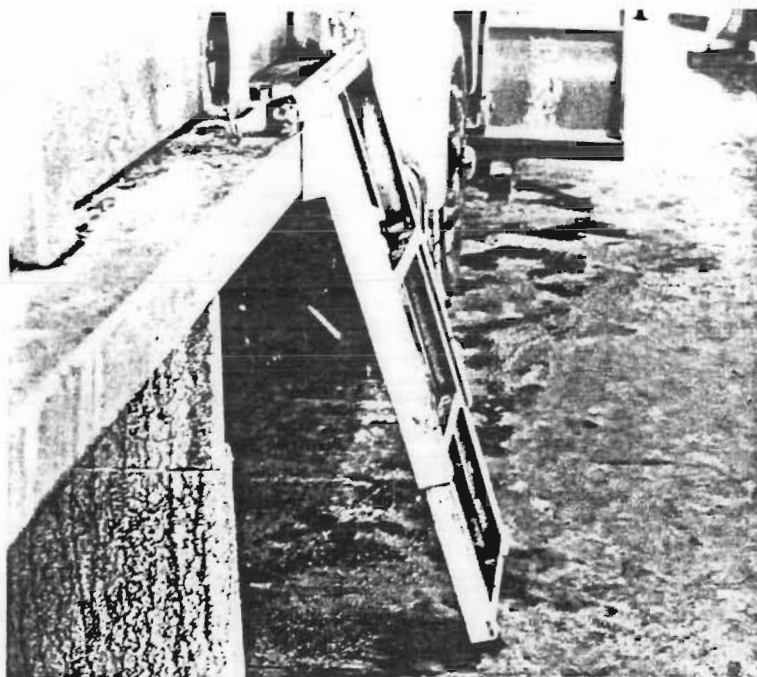
Iowa Sign Trailer and Folding Signs



Iowa Sign Trailer with Folding Support
for Flashing Sign



Iowa Truck Ladder - Stowed



Iowa Truck Ladder - Extended

LITERATURE

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