CURRENT PROGRESS IN ROADSIDE DRAINAGE DESIGN

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This is not a report but a brief summation of the highlights of last year's report on grading and drainage. Because of printing delays, copies of the report were only recently distributed to members of the Committee.

Through the Coordinators, the Committee plans to obtain more complete information on the drainage of roadsides. We need more information, especially on methods and practices that will apply during maintenance of old highways as well as the application of improved design for drainage on new highways. The published report of the Committee on roadside grading and drainage outlines the principles basic to the classification of types of highway drainage problems in the six major climatic regions of the country.

A brief review of some of the changes which have taken place in the concept of highway drainage may be helpful. Twenty years ago, the Committee on Roadside Development was organized by a small group of states interested in roadside matters. Up to that time, our roads had been built largely by engineers with a background of railroad building. The average road was at first just a narrow piece of pavement with deep V ditches and steep erodible back slopes on an all-too-limited width of right-of-way. The resulting scars of construction formed such "eye sores" that public attention was drawn to the ugly roadside conditions of the time.

The Committee on Roadside Development was organized in 1930 to help the states correct such conditions and develop improved roadsides. The development of the streamlined cross section by the state highway departments is now also being recognized by some railroad officials. Evidence of this may be noted in the fact that several railroad companies are reshaping the cross section of the railroad right-of-way to prevent erosion and reduce maintenance.

The interdependence of grading, drainage, and erosion control has been demonstrated by the states and has been covered in past reports. Today, as already noted, we find that the railroads are also beginning to give attention to these principles of streamlined development. Examples here and there show that resectioning of old road and railroad construction is a practical matter of economy in transportation operation. We have moved from piecemeal thinking of drainage as a separate ditch problem along the side of the road to a more complete conception of highway drainage as an integrated system of design incorporated in the basic construction. The highway engineer is concerned not only with drainage <u>on</u> the highway right-of-way itself, but also with the problem of water running down from lands <u>above</u> the highway as well as his own responsibility in the disposal of water on lands <u>below</u> the highway.

In other words, the concept of complete drainage as a matter of land conservation and of cooperative public relations by both the highway builders and the property owners is gaining ground. The engineer in earlier days simply tried to get rid of the water and tried to get it off the highway right-of-way as fast as he could. Today, that concept is fast changing. We are now trying to slow down the movement of water to reduce erosion. The rounded, wide-bottomed drainage design instead of the old V-ditch, and the application of mulch, for example, are becoming routine operations as a part of Federal-Aid highway-construction specifications. The practice of mulching is saving the states money, because mulch not only slows down the velocity of water on slopes but it also helps in absorbing water into the soil. This soil moisture makes a better environment for the growth of vegetation at the lowest cost. At the same time, keep in mind the important point that mulch materials on slopes protect the surface of bare soil from the "splash" of rain drops. Mulch does two things: It stops the start of erosion on the surface and it slows down the water to a non-erosive velocity.

Current examples of three types of drainage problems might be of interest:

1. Drainage is a vital factor in shoulder stabilization. As Mr. Crum pointed out in the general session yesterday morning, the loading test in the Maryland test project shows that there is a definite relationship between the pavement, the base, and the sub-base. In the design of stabilized shoulders, not only the pitch of the surface but the cross pitch or slope of the subgrade is also important. Other committees in the Highway Research Board should be interested in helping us in that problem so that a standard rate of pitch of the subgrade might be developed and used for each respective classified condition. Practices among the states vary widely. The subgrade may be level in some cases; a pitch of 1/8 inch per foot may be specified in other cases; only a few specify $\frac{1}{4}$ inch per foot pitch. Some engineers think that as much as $\frac{1}{2}$ inch per foot might be better in certain cases.

In the new cross sectioning of the Pennsylvania Turnpike extension, as reported on page 35 of the June, 1950, issue of CONTRACTORS AND ENGINEERS MONTHLY, a 10-foot stabilized shoulder is used with a pitch of one inch per foot, and the surface of the subgrade has a slope of 1/6 inch per foot under the pavement. The Standard Specifications of the Texas State Highway Department require a pitch of $\frac{1}{4}$ inch per foot for earth subgrades under the pavement. This type of cross section design represents an adaptation in principle of figure 12 on page 115 of the 1945 Proceedings of the Highway Research Board. This is a new type of problem that might be referred to the Soils Committee on Subsurface Drainage.

2. A second matter is that of control of snow drifting, fundamentally a problem in air drainage. We need information on how far we can go in eliminating guard rails through flattening of slopes. Studies of state highway department policies and practices with respect to eliminating guard rail in snow country especially indicate that the heights of fill at which it would be economical to eliminate guard rail by flattening slopes to 4:1 range from 7 to 12 feet, or say, 9 to 10 feet under average conditions.

3. The use of wider-bottomed sections in drainage ways is another important factor in modern design.

Rounded shoulder slopes and ditch design in the continuous type of cross-section development have expanded the use of machine equipment in highway construction and maintenance. In the Dakotas, for example, they have adopted the plan of using:

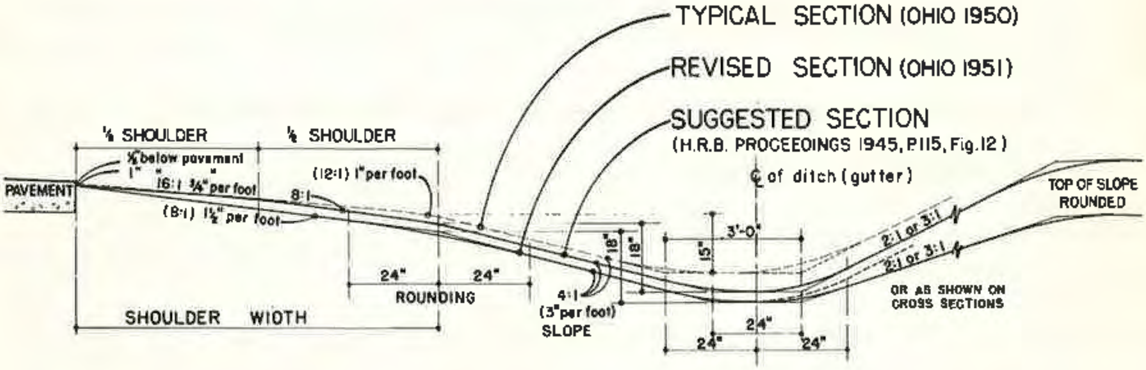
1. 4:1 front slopes from the edge of the shoulder down to the drainage way.

2. Wide-bottomed drainage ways for snow storage; and

3. 5:1 back slopes for the control of snow. The flat back slope has been found necessary for control of air currents causing snow drifting. With such a streamlined grading operation air currents are not slowed down to the point of depositing snow on the traveled way.

An example of the need for certain revisions in highway cross sectioning to facilitate surface drainage adjacent to the pavement is illustrated in the attached figure showing three types of rounded design in relation. The present serious conditions in highway maintenance have caused us to reappraise our design standards. Designers are of the opinion that we should get the water away from the pavement edge as quickly as possible, and at the same time provide greater depth for the roadway ditches. Note in the figure that these requirements are met by using a rounded cross-section with an increase in shoulder pitch.

Working together, through the Coordinators, we can get more information on these types of drainage problems in each region.



Rounded Shoulder, Slope and Ditch Design

An example of the interdependence of roadside grading, drainage, and erosion control in highway design was given by Mr. Cron in the 1948 Report of the Committee on Roadside Development published in December, 1949. Illustrations of slope design in the Great Smoky Mountain National Park will be found on pages 35-50 of that annual report. The published photographs were taken in August 1948.

Mr. Cron has been keeping in close touch with the results of this project and now, after two years of observation, he is here to tell us what has happened in the two years--1948-1950.

Mr. Cron presented kodachrome slides of the same slopes taken in December, 1950. This is a record of his observations on slope design after two years of operation. He stressed the fact that this seeding project has been satisfactory. There has been no erosion and the ditches have received no cleaning in spite of the fact that a large part of the project consists of shale on a $1\frac{1}{2}$:1 cut slope and was not seeded. There has been, however, some ravelling of the shale in which this project has demonstrated the importance of a heavy generous rounding in the top of the slope to stop erosion and effects of freezing and thawing. After two years of experience with unprotected slopes, just the top of the slope has been seeded and there has been no erosion. There has been considerable volunteer growth coming on in these slopes from the adjoining woodlands. Grass is a temporary cover except on the shoulders.

There are a few places where ditches in steeper grades have deepened themselves sometimes as much as a foot. The maintenance men have found a cheap and effective way to deal with this. They get fragments of rock from the size of a baseball up to about $\frac{1}{2}$ cubic yard and put these in the ditch. The largest pieces are placed first with smaller pieces in the crevices. The grass and other plants take root and that halts the downward erosion of these ditches. No pipe stoppages have been found.

Mr. Cron showed contrasting views of a project on which 2 inches of topsoil was used, and another job which had topsoil on the shoulders but no topsoil on back slopes. To this day, he stated, he cannot tell the difference as far as turf is concerned between areas where topsoil was placed and where it was not.

DISCUSSION

Mr. Izzard: I would like to mention this matter of the ditches eroding, brought out by Mr. Cron. Two things control the amount of erosion in channels: (1) the depth of the water; and (2) the slope or profile at which the channel is placed. If the slope is fixed, it is the depth of water that causes the soil particles to move. Anything that spreads the water out and makes the gutter shallower will reduce erosion.

Another interesting point Mr. Cron made was that there was no clogging of culverts. We have research projects covering transportation of sediment in pipe lines. We are finding that where culverts or other pipe lines must be expected to carry sediment, they must be enlarged, if they are to keep themselves clean. In engineering terms, the value of the roughness factor in Manning's formula goes up very rapidly with comparatively small increments in the percent of sediment in water carried by a small pipe. These experimental results have not advanced far enough to give out any data yet. It is definitely indicated that if sediment is to enter a pipe, you better make extra allowances in the slope or fall (of the profile) of that pipe.

Mr. Simonson: I would refer you to the "Highway Magazine" for December, 1950. As Mr. Izzard pointed out at another meeting, we tend to think of highway drainage in terms of the humid East where vegetation is used to stop erosion. In this magazine is a feature article titled "Highway Drainage Problems in New Mexico." It shows that they too have drainage problems and that the same principles we follow in the East apply -- in that we want to slow down water and keep it off the highway. Dispersal, not concentration of water, is the main point to keep in mind in design for the elimination of erosion.

As Mr. Izzard brought out in his 1943 report of the Subcommittee on Drainage and Drainage Structures: "Drainage practices are distinctly different in humid regions where vegetation can be relied on to control erosion as compared with those in dry regions where vegetation can be established only with difficulty. In regions of deficient rainfall, the emphasis is on keeping water away from the highway.

"In both humid and dry regions water should be discharged from the highway as soon as possible in a manner which will not cause damage to property below the highway."