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DESIGN AND USE OF SHOULDERS, DITCHES AND BACK SLOPES ON HIGHWAYS

By
C. N. Conner, Bureau of Public Roads, Chairman,
Department of Design, Highway Research Board

The utility, safety and appearance of a highway depend in no small measure on the design and maintenance of its shoulders, ditches and back slopes. When poorly designed or inadequately maintained, shoulders and ditches account for irreconcilable maintenance costs and a shockingly large number of accidents. It is possible and practicable to make designs that will reduce the number of severity of traffic accidents and definitely cut maintenance costs. A review of recent statements by highway authorities, examination of current designs of State highway departments, and a glance at some 2,000 maintenance reports show clearly enough the inadequacy of most old designs for modern traffic. Now is the time to review and appraise design practices and to follow those trends and objectives which lead to greater traffic safety. Present traffic is fast, future traffic will be faster - speeds up to 100 miles per hour may be expected. This fact cannot be lightly set aside. We must meet the situation squarely by designing new roads and reconstructing old roads to serve this traffic and reduce the number of fatalities. It is estimated that approximately 30 per cent of all highway fatalities may be attributed to design and location. Soft shoulders, deep ditches and narrow culvert headwalls are the direct cause of many accidents.

Let us examine with critical eye the designs of a few years ago, current practice, and trends in the design of modern two-lane highways. The average two-lane highway on State highway systems expected to carry up to 4,000 or 5,000 vehicles daily has a width out to out of shoulders, of from 30 to 36 ft. Most of the older designs and many of the modern ones show a width of 30 or 32 ft. The pavement width on these sections varies from 18 to 24 ft. Most current designs have a 20 ft. pavement, and there is a definite trend toward a width of 22 ft. The shoulder width on these sections appears to have been fixed at whatever distance remained after the pavement had been accommodated.

Right of Way. Except for a few unhappy property owners, no one questions the need for right of way sufficient to accommodate generously construction requirements. Too little, however, is being done to obtain wide rights of way. In the past roadways have been largely limited to those dimensions which could be constructed within minimum right of way

limits, with too much stress on saving money and too little regard for saving life. Although recognizing that wide right of ways are desirable to inclose roads designed for modern traffic, too few highway authorities have definitely determined to obtain adequate right of ways. We cannot reasonably expect to reduce accidents without providing areas sufficiently large to contain safe highways.

Shoulders. In the past we have said that the purpose of shoulders was to provide parking space for broken-down vehicles and we built thousands of miles of relatively wide shoulders with that thought in mind. Actually, however, modern vehicles are less subject to breakdowns than formerly and the need for parking on shoulders to make repairs is greatly reduced. It is, of course, still necessary to keep the occasionally parked vehicle off the pavement and outside a point 10 ft. or so from the center line of the road. Commendable efforts are being made to provide extra shoulder width at rural mail boxes, bus stops, and special parking areas just off the road where scenery may be viewed without obstructing traffic. Shoulders, however, have two other important functions; first, that of protecting the pavement from damage by water and melting snow, and second, that of providing an all-weather waterproof surface for vehicles in motion which have been forced off the pavement surface.

The width of shoulder on most existing roads has been fixed by the width of grading and width of pavement. Some roads have pavements 18 ft. wide and shoulders 7 ft. wide, others have 20 ft. pavements and shoulders 5 or 6 ft. wide. It is apparent that roads already graded to a width of 30 ft. and paved to a width of 18 ft., having waterproofed shoulders 6 ft. or less in width, are less hazardous to traffic and less liable to damage than roads having pavement 20 ft. wide and earth or grass shoulders 8 ft. or more in width. A desirable section for a modern two-lane highway would be one having a paved width of 22 ft. and gravel, stone or slag shoulders, bituminous treated, having a width of 8 ft. Such construction, however, is necessary only on two-lane roads carrying or likely to carry traffic relatively heavy in weight and large in volume.

Materials commonly used in shoulders are those available locally, which, in too many cases, means ordinary earth. Other materials such as gravel, stone and caliche, when available, are used extensively to good advantage. For best traffic service and lowest maintenance costs, shoulders of granular material should be improved with a low-cost bituminous surface 1 to 4 in. deep, depending on the amount and weight of traffic likely to use them. Grass or sodded shoulders on heavily traveled roads, particularly those of inadequate pavement width, cannot be maintained in a satisfactory manner at reasonable cost because traffic prevents the growth of grass and cuts the shoulders extensively. It is advisable, therefore, to consider the use of grass or sodded shoulders only where traffic is relatively small in volume and where there are few buses or wide trucks likely to run off the pavement. Grass shoulders, although attractive in appearance, are dangerous when wet or soft. Ordinary earth shoulders, when rutted and eroded at the pavement edge, are particularly hazardous. Damage to the best of pavements is sure to result from water entering ruts and percolating beneath the pave-

ment. Shoulders constructed of gravel, slag or crushed stone are greatly superior to those of grass or earth. However, they become dusty or eroded and relatively expensive to maintain when flanking pavements of inadequate width. Best of all are shoulders treated with bituminous materials. They should be used without hesitation to protect traffic and pavement until a more substantial widening is needed. If funds are not available for waterproofing the full width of shoulder a relatively narrow transition strip of a low-cost bituminous mixture at the edge of a too narrow pavement will greatly reduce maintenance costs and accidents. Snow removal is facilitated where shoulders have been treated with bituminous materials, and maintenance reports show definitely that shoulders of this character protect the adjacent pavement against the disastrous effects of freezing and thawing. Extensive pavement failures and fatal accidents may be traced directly to low and rutted shoulders. Lean and skimpy designs are responsible for a large number of highway accidents. Many of them could have been prevented by generous sections calling for wide bituminous treated shoulders, long culverts, and wide bridges.

Ditches. All roads should have adequate cross drainage and adequate side drainage. Intercepting ditches and berm ditches should be constructed outside the tops of cuts, particularly in rolling and mountainous country, to prevent surface water from eroding back slopes and entering and overflowing side ditches. Drainage ditches leading from the roadway should be constructed in flat country to remove water quickly from the vicinity of the highway. All ditches or gutters should, of course, have sufficient slope to carry the run-off water without erosion. On steep grades, and in light soils on any grade, erosion may be prevented by numerous well-known means such as paved gutters, ditch checks of stone, timber or other materials, and plenty of pipe culverts under the road. Pipe placed below shallow side ditches parallel to roadways are used with success instead of deep ditches. Although relatively expensive as compared with open ditches, they definitely reduce traffic hazards and provide adequate drainage at reduced maintenance costs. They may be the best solution to drainage problems resulting from inadequate right of way.

Present practice shows a definite trend toward the use of wider and shallower ditches or gutters rounded at shoulders on the inside of the road, at flow line of the ditch, and at slopes of cuts.

Back Slopes. Until recently the rates of slope on back slopes in cut, and side slopes in fill, have been the steepest that reasonably would resist the action of the elements. Little thought had been given to their effect on highway safety. Cuts were commonly sloped at the rate of 1 to 1 or 1½ to 1, fills at 1½ to 1 or 2 to 1. Except in rare instances little thought was given to rounding or flattening slopes so as to reduce erosion or to sloping low fills gently to increase highway safety. Briefly stated, past practice in too many cases called for grading which would provide highway facilities quickly at minimum cost without due regard to traffic safety. These old designs, suitable perhaps for the needs of the past, are responsible for many present day accidents and high maintenance costs.

Current practice and present trends show slopes in some cuts and most fills to be rounded and flatter than formerly. It is usual for shallow fills 5 ft. and less in height to have side slopes of 4 to 1 or flatter. On the other hand, in mountainous country involving heavy side hill cuts, shoulders and ditches are sometimes omitted entirely and an extra width of pavement with a paved gutter or curb is used instead. Grading costs are greatly reduced thereby. In flat or gently rolling country, sections are being constructed which call for the use of extra wide fills having flat side slopes, instead of relatively narrow fills with steep side slopes and guard rail, especially where fills are long.

No discussion of the subject would be complete without consideration of the utility of lip curb in pavements. The Mississippi Valley Conference at a recent meeting did not come to definite agreement on this matter. Some of the engineers present believed lip curbs should be used practically everywhere. Others believed they should be used only where there is a substantial flow of water along the road to prevent ruts caused by running water. It is believed by some that lip curbs reduce the effective travel width by about one foot on each side of the pavement. Lip curbs decrease the possibility that water from shoulders will seep laterally under a pavement, but they increase the possibility of seepage to the subgrade through pavement joints because the pavement carries more water on its surface when lip curbs are used than when they are not. There is also a possibility of water ponding on the surface of the pavement when side outlets through the lips to ditches are not properly designed.

More than 20 years have elapsed since Upham obtained minimum 100 foot right of ways for the original two-lane Dupont Road in Delaware, graded it to a width of 32 ft. out to out of shoulders, placed all culvert headwalls 32 ft. in the clear, sloped fills under 5 ft. in height at the rate of 3 or 4 to 1, drained swamps, built wide shoulders and shallow ditches, concealed and drained all borrow pits, planted trees and grass along the roadside and by-passed towns. That practice is still good.