

The danger potential of a clear roadside is directly related to the slope of the terrain; the more gentle the slope, the safer the roadside.

The angle of a slope is most commonly expressed as a proportion, two-to-one, six-to-one, and so forth.

For example, this is a two-to-one upslope—quite a steep grade.

This means that in two feet measured horizontally, the height increases one foot.

Accordingly, a four-to-one slope increases one foot in four, and an eight-to-one slope one foot in eight.

Downslopes are described in the same manner, but the heights are, of course, diminishing.

This test illustrates the danger of impacting a two-to-one upslope at 35 mph.

A similar test on a four-to-one slope produced better results, but even this grade could produce injury or damage at higher vehicle speeds.

On the Proving Ground, maximum upslopes of six-to-one are applied, as these are safely traversible, even at 60 miles per hour. This grade produces the needed safety for high-speed roads and could be applied generally on most public highways. If steeper slopes are necessary, they must be well rounded.

The contour of the ditch bottom and road shoulder are as important for safety as the slope itself, for it is obvious that a car can travel over gently rounded contours with far greater safety than thru the sharp angles of the traditional V ditch. This design is not only safer, it is easier to maintain as erosion is reduced and mowing machines can operate without difficulty.

When the roadside slopes downward, the possibility of roll-over increases as shown on this four-to-one grade.

With the downslope reduced to six-to-one, the car tends to spin, rather than roll on firm soil. From these and other tests, it was concluded that the maximum safe grade for any road is six-to-one, but preferably flatter. From the standpoint of safety, the less grade, the better!

A sloped roadside should also be free of surface irregularities to be really safe—eroded surfaces that could upset a vehicle skidding laterally can be smoothed and seeded at a nominal cost and, with proper grading, small parallel ditches could be eliminated in favor of gently rounded depressions a safe distance from the roadway.

Where drainage requirements are such that deep parallel ditches are needed, underground drain systems should be considered because of the extreme hazard presented by these excavations and this same correction must be applied to transverse drainage systems, including small creeks and culverts. This need is absolute to eliminate dangerous headwalls and bridge abutments. While underground drains increase the cost, the end result is well worthwhile as this creates a safe roadside, completely free of obstacles.

While a clear roadside is the ideal, many natural and man-made obstacles cannot be eliminated. In dangerous areas, the only solution is to install some form of guardrail.

Unfortunately, there is no such thing as a perfect guardrail—any guardrail in itself is a hazard as any impact produces some degree of risk and damage. For those reasons, guardrails and barriers should be installed only at those places where hazards cannot be eliminated.

For example, guardrails are absolutely needed on bridge approaches to protect an out-of-control vehicle from the steep embankments, and against the possibility of hitting the bridge abutment.

The guardrail should be firmly attached to the inside of the bridgerail to protect against this possibility.

Lakeshores and other natural obstacles also require guardrail. Guardrails are used only at those locations where roadside hazards cannot be eliminated, and this same practice should be applied on our public roads.

At the Proving Ground, the result of the roadside hazard studies have now been in effect six full years.

Roads that were once lined with trees close to the pavement have now been cleared for a distance of 100 feet on each side, and all other obstacles have been eliminated. In their place, shrubs and bushes are being planted to further enhance the beauty of the site.

Dangerous parallel ditches have been eliminated from the roadside and all side slopes are now as flat as possible, with none steeper than six-to-one. All grade contours and ditch bottoms are gently rounded. Our records and other cost studies show that ditch and grading improvements can be made reasonably, and that this cost is amply justified in accidents prevented.