Highway Shoulders Construction Practices

C. H. SHEPARD, Soils Engineer, Bureau of Construction
Ohio Department of Highways

●DURING the last two decades, Ohio has gone through a wide variety of shoulder practices. Twenty years ago it was the practice to use a 4-in. thickness of granular material at the pavement edge. The granular material was not stabilized or sealed and was at times unstable and trapped water. Then during a period of many years, it was general practice to provide soil berms with grass to the pavement edges on heavily traveled primary roads as well as lightly traveled secondary roads. This policy beautified the shoulders, but it created hazardous shoulders of low wet weather stability. Heavy vehicles frequently use the shoulder on heavy duty roads, resulting in high maintenance costs and some pavement failure. The lack of suitable shoulders encourages heavy vehicles to make emergency stops on the through traffic lanes, causing considerable delay and confusion as well as serious traffic hazards.

Now the policy for new construction provides stabilized shoulders along the outside pavement edge of all divided pavement highways, and along each edge of all two-lane pavements with more than 200 heavy commercial vehicles per day. Seeded earth shoulders are still generally used on low traffic roads. Figure 1 shows a standard typical section using earth shoulders. Features intended to facilitate rapid runoff of surface water (of primary importance for good shoulder maintenance) are the shoulder finished 1 in. below the pavement edge, shoulder slope of 1 in. per ft, and deep side ditches with a minimum depth of 18 in. below the outside edge of the shoulder.

Stabilized Shoulders

The present standard for stabilized shoulders (Figure 2) consists of a 4-ft width of stabilized crushed aggregate, 6-in. compacted depth, finished flush with the pavement surface, with a slope of ¾ in. per ft. Materials for this course are crushed limestone, crushed slag, or crushed gravel. If gravel is used, specifications require that the portion retained on a No. 4 sieve shall contain not less than 40 percent fractured pieces. Specifications require a well graded material with a 2 in. top size, with 0 to 15 percent passing the No. 200 sieve, and a plasticity index of not more than 6. In addition, the physical characteristics of the material must be such that it will compact to the satisfaction of the engineer.

Figure 3 shows the shoulder detail for a flexible pavement project with a stabilized crushed aggregate shoulder (Ohio Project 36(1955) now under construction). The 4-ft wide stabilized shoulder has 6 in. compacted thickness and a slope of 1 in. per ft. The subbase is extended through the shoulder to the ditch on a slope of $^3/_{16}$ in. per ft to provide drainage.

Figure 4 shows the shoulder detail for Project 184(1953), a four-lane divided highway on a new location 9 miles long. Throughout the project, this shoulder treatment was used on the median sides as well as on the outside edges. Excellent drainage provided by longitudinal pipe underdrains minimizes problems during wet weather construction and insures adequate drainage. The shoulders on this project are in excellent condition after one year of service, with practically no shoulder maintenance necessary.

Other types of stabilized shoulders have been used in Ohio. Calcium chloride and sodium chloride have often been used successfully in stabilized aggregate shoulders. Ohio Project 205(1955), now under contract, specifies aggregate shoulder material stabilized with portland cement where the pavement grade is between 4 and 6 percent. Erosion of shoulders at the pavement edge has been a problem on other projects with similar grades, and the cement stabilized shoulders are to resist erosion. Ten percent cement by volume will be used. The shoulders will be inspected periodically after construction. The dimensions of the cement stabilized shoulders are 4 ft wide and 6 in. deep. The aggregate and cement may be plant-mixed or mixed-in-place and will be compacted and cured in a manner similar to that specified for soil-cement base construction.

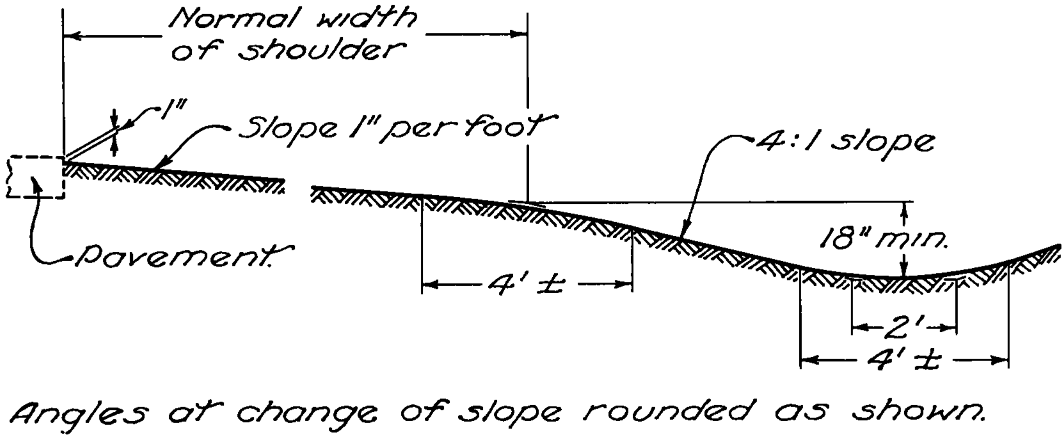

Figure 1. Standard section using earth shoulder.

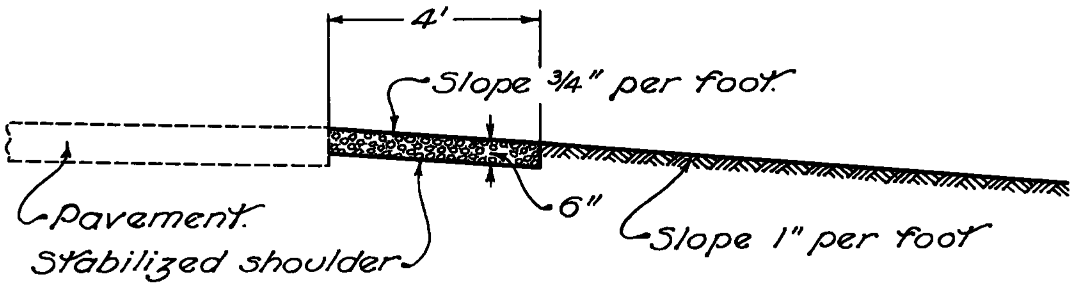

Figure 2. Standard section using stabilized shoulder.

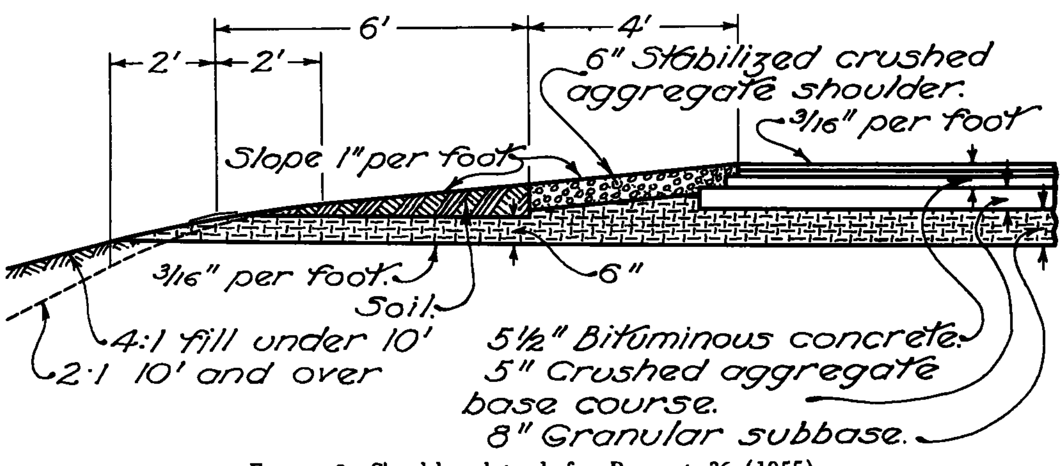

Figure 3. Shoulder detail for Project 36 (1955).

Construction Methods

Shaping the subgrade for the standard stabilized shoulder course is usually done with a motor grader, often with a special blade of proper dimensions for the purpose. Figure 5 shows a trench for the stabilized shoulder being cut. The subgrade for the stabilized shoulder is rolled until the compaction is not less than the specification requirement, which varies from 98 to 102 percent of Standard AASHO Method T-99 depending on the soil being compacted. The higher percentages of compaction are required for the lighter weight soils. A trench roller is usually used for rolling the subgrade, although other types of rollers are permitted provided specified compaction is obtained.

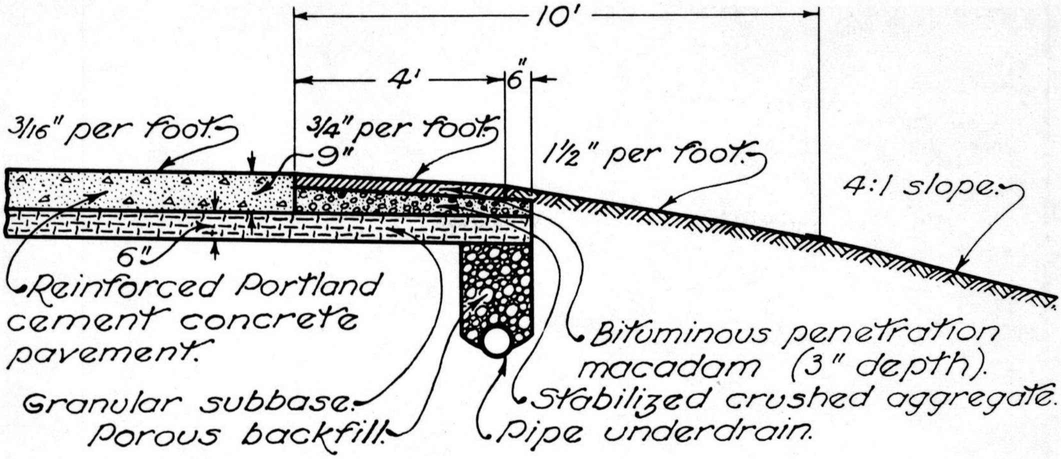

Figure 4. Shoulder detail for Project 184 (1953).

Check tests for subgrade density are made by either the sand or cylinder density method. A template is used to check conformity to plan lines.

After the subgrade is shaped and compacted, the crushed aggregate is spread upon the subgrade in layers not to exceed 6 in. compacted thickness. Usually the crushed aggregate is spread in one course with a mechanical spreader, as shown in Figure 6. A rear view of the spreading operation is shown in Figure 7, which also shows a power broom towed behind the spreader, here being used to keep the pavement free from loose aggregate.

For initial compaction of the stabilized shoulder material, specifications permit the use of any suitable equipment approved by the engineer. For final compaction of the surface of the stabilized shoulder, the use of approved pneumatic tired equipment is required (Figure 6). Moisture-density principles are used in compaction control. When ordered by the engineer, water is applied to aid in compaction and prevent segregation. The material is compacted to the density established as satisfactory by field density tests. The sand method is used for compaction control, and compaction is not considered satisfactory until the density in the compacted stabilized shoulder is as high or higher than the density at optimum moisture as determined by Standard AASHO Method T-99 using that fraction of the material which passes the ¾-in. sieve.

The number of density and moisture checks required for control during construction is not great where the work is proceeding smoothly and uniform materials are being compacted. If adequate densities are being obtained and proper moisture content is being maintained, the job of inspection is principally one of determining the number of passes of the roller which will achieve the desired result and seeing that this number is actually made. Under such conditions, only one or two density checks per day are sufficient.

Construction Problems

Effective compaction control procedures and continual inspection during construction are necessary to insure adequate compaction of stabilized shoulders and the subgrades. Side ditches and shoulders must be properly shaped at all times during construction to provide proper runoff during rains and to prevent

Figure 5. Subgrade for stabilized shoulder being prepared with motor grader.

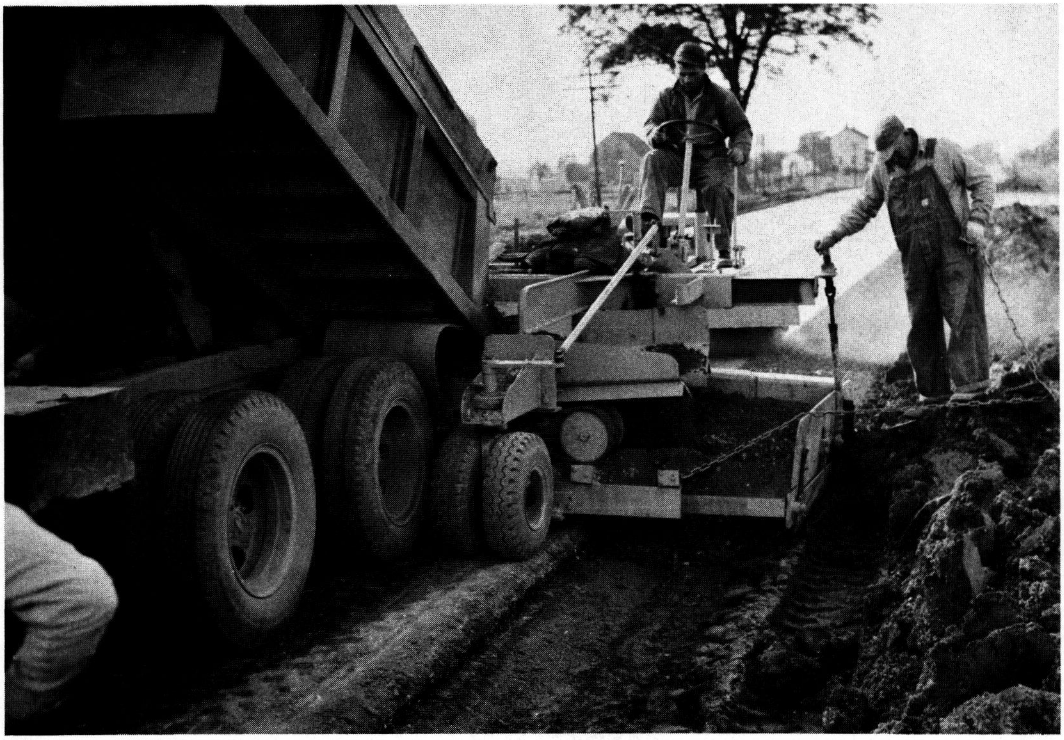

Figure 6. Stabilized crushed aggregate shoulder material being placed with mechanical spreader.

Figure 7. Rear view of spreading operation, showing towed power broom being used to keep pavement clean and free from loose aggregate.

Figure 8. Pneumatic tired roller being used to compact stabilized crushed aggregate shoulder.

ponding of water on the roadway. Construction trenches through the shoulders are necessary to provide for proper drainage of surface water from trenched pavement and shoulder sections. There seems to be a general tendency for contractors to neglect cutting drainage trenches through the shoulders during construction, and constant attention by the engineer is usually necessary to insure that these trenches are established and maintained where needed.

To improve practices for the construction of flexible pavements, it has been proposed to keep all heavy construction equipment and trucks hauling materials off of the finished subgrade, subbase and base courses during construction, and to require all equipment not needed in the construction of the pavement to use the shoulders. It is anticipated that such requirements will create problems in shoulder construction. Heavy traffic on the shoulders during pavement construction will interfere with maintaining construction trenches across the shoulders and will create rutting of the shoulders, making it difficult to keep the shoulders properly shaped to maintain adequate drainage of surface water during construction.

On heavily traveled primary roads, there is an unquestionable need for stable shoulders with some type of paved surface to provide surface drainage. Maintenance forces, as facilities permit, are now engaged in a program of applying bituminous surface treatment to shoulders which have been previously maintained for several years as stabilized aggregate shoulders. For new construction on primary roads, where granular stabilized shoulders with no binding surface are provided, shoulder problems are being passed on to maintenance forces. To meet future needs on primary roads, it is indicated that stabilized shoulders, provided during construction with some type of bituminous surface, will be necessary.