we spread a liberal coating of limestone screenings, gave it a good sprinkling, applied about 2 lb. of calcium chloride per sq. yd. and then bladed the mixture to a smooth surface. In one or two cases this was followed by rolling which helped consolidation. Good results were secured, however, on thinner applications without rolling. This resulted in a smooth, hard, durable surface that surprised all who inspected it.

With our limited equipment and personnel, it was not always possible to blade these treated roads after each rain or to make the repeat applications of calcium chloride promptly when needed. To patch some of the deeper potholes which developed at certain spots we used a mix of limestone screenings, calcium chloride and water, made in an old concrete mixer. About one sack (100 lb.) of calcium chloride was used to a cubic yard of screenings and enough water to give a consistency like a dry-mix concrete pavement batch. These batches were truck-hauled to the road, shoveled into the potholes, struck-off high enough to allow for compaction and left for traffic to consolidate. The results were very good.

Whether the excellent results of these calcium chloride treatments were due to the type of limestone used, the consolidation of the heavy traffic, or to other factors, we do not know. But to this person who has had a little experience in highway work the end results were amazing. Dust was eliminated, blade maintenance and stone replacement were tremendously reduced and the resulting surface hardness (like concrete) carried steel-tread tank traffic with practically no impression.

In conclusion, may I say again that our primary mission was to provide, not boulevards or super-highways, but good, durable traffic arteries which would keep the tanks, half-tracks, trucks and jeeps rolling and the field training program in full swing. Despite the fact that we received several "skins" from the visiting inspectors, we are satisfied that we did a pretty fair job while contending with a lot of handicaps.

AN EXAMPLE OF GRAVEL BASE CONSTRUCTION IN MARYLAND UNDER HEAVY TRAFFIC CONDITIONS

By J. Eldridge Wood

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During the early part of the war, Maryland had to extend her road building activities.

The many military installations, and defense plants demanded and obtained access roads. This was accomplished with a degree of promptness, not only satisfying, but sometimes surprising to the road builder.

Many highway department employees left for the armed service. Equipment repair and replacements were hard to obtain or unobtainable, construction materials were so much in demand that at times the very plant or camp to be accommodated by the highway was contesting, and often with success, for the same materials needed in the road. Contractors who had depended on State road construction almost exclusively, were diverted to plant, airport and camp projects.

This combination of circumstances brought about one of our most complicated problems and its solution may prove interesting. It shows that it is possible to carry traffic loads heavy in both weight and number on a conventional bankrun gravel road stabilized with calcium chloride.

St. Mary's County, in Southern Maryland is a peninsula, surrounded on three sides by the navigable waters of the Patuxent River, Chesapeake Bay and the Potomac River. As it is a rural community, highway needs were modest and two roads of the farm to market type, planned to accommodate 500 vehicles a day, adequately served its need for transportation to Baltimore and Washington.

A single track railroad was available to the extreme northern part of the community, but was little used.

About 15 miles from the terminus of this railroad, and accessible only by the aforementioned two roads, the U. S. Naval Air Station Patuxent River, Maryland, had been built. During 1943, when construction of the base was at its peak, all materials and personnel used on the project, came overland by one or the other of these two highways.

The roads showed immediate distress, and the Three Notch Road, 18 miles long, and the most direct route, was designated an access project and rushed to completion with extensive relocation, wider section and higher type surfacing. During this construction period the single track railroad was also extended to the Air Base. This forced practically all traffic to use the only other road—the Red Gate-Great Mills Cedar Point Route. This route was maintained as a gravel road until 1925 and then surface treated with bituminous material.

Since all traffic was diverted to this route, a traffic count on passenger cars showed over 2000 in four hours (from 6 A.M. to 10 A.M.), and one producer alone hauled an average of 2200 tons of concrete aggregate per day.

This heavy traffic load caused potholes and ravelling, and exposed what remained of the gravel base, which was originally 9 in. thick, and had had several additional applications of 2 to 4 in. of bankrun gravel. However, in the 23 years that had elapsed since construction, this material was contaminated with the subgrade to such an extent that only 2 to 4 in. of base course type gravel supported the surface treatment mat. This mat was about 2 in. thick.

In February 1943, it became necessary to maintain a reasonably high speed road capable of supporting heavy overloads.

To meet these conditions the old, badly worn surface treatment was scarified and bladed to the shoulder so as to reduce the crown and provide a wider section of 24-ft. minimum width. This was covered with 9-in. of bankrun gravel and as soon as consolidation occurred, it was covered with a second course of 5 in. Two pounds per square yard of calcium chloride was immediately applied. The gravel was uniform in type, and complied with Maryland gravel surface course specifications. Table 1 gives its characteristic qualities. The physical characteristics of several samples of the subgrade soil are given in Table 2.

Some breakups quickly appeared, caused by inferior subbase. Sometimes it was necessary to remove this material, but usually gravel was added and calcium chloride mixed with the surface.

Maintenance consisted of shaping and sometimes scarifying with blade graders, the filling of potholes with mixed gravel and calcium chloride and retreatments of calcium chloride or gravel when needed. The heavy and fast traffic caused excessive wear and frequent blading was required. It was found that a dense, tight and hard surface could be secured even through the dry summer months with frequent relatively heavy applications of calcium chloride, and that this would provide a compacted and glossy surface that was free of float and gave the appearance of a light bituminous prime, recently applied.

TABLE 1
SAMPLE OF PIT RUN GRAVEL
31.3 Per Cent Passing No. 40 Sieve, 12.9 Per Cent Passing No. 200 Sieve

Passing Sieve Size				Particles Smaller than 2 mm.: No. 10 Sieve						
				Passing Sieve No.						
2½ in.	1 in.	¼ in.	No. 10	40	200	Coarse Sand, 2 to 5 mm.	Fine Sand, 0.25 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay Smaller than 0.005 mm.	Colloids Smaller than 0.001 mm.
%	%	%	%	%	%	%	%	%	%	%
100	100	94	46	68	28	50	29	8	7	6

Liquid Limit	Plasticity Index	Shrinkage		Field Moisture Equivalent	Soil Group
		Limit	Ratio		
25.1	5.7	19.5	1.64	21.4	A-2

TABLE 2
PHYSICAL CHARACTERISTICS OF SOIL

Sample No.	Per cent Passing Sieve No.		Material Passing No. 40 Sieve					
					Shrinkage			
	40	200	Liquid Limit	Plasticity Index	Limit	Ratio	Field Moisture Equivalent	Soil Group
SM-92	98.7	84.5	36.2	13.6	21.6	1.69	27.8	A-7-4
SM-93	93.6	81.2	43.2	20.1	19.5	1.74	32.7	A-7-4
SM-94	88.3	59.2	20.6	4.5	16.6	1.81	17.4	A-4
SM-95	98.4	62.4	20.4	3.6	18.3	1.79	19.1	A-4
SM-96	90.9	72.8	28.2	11.6	15.9	1.79	23.2	A-4-7
SM-97	98.8	77.8	31.2	11.7	20.8	1.70	26.7	A-4-7

From February 24, 1943 to September 6, 1943, an average of 4.7 lb. per sq. yd. of calcium chloride was used, or a total of 245 tons on the 7.4 miles treated.

In mid-September this roadway had developed into an excellent stabilized base. It presented a dense surface, was well compacted and of uniform section. The cost of this work averaged 36$\frac{1}{2}$ cents per sq. yd. As the next step, a prime coat of one half gallon of R. T. 2 tar and a seal coat of $\frac{1}{3}$ gal. of R. T. 6 tar was applied and covered with chips, passing the $\frac{3}{8}$-in. sieve. This surface treatment cost 17$\frac{1}{2}$ cents per sq. yd. The total cost for gravel surfacing, calcium chloride and surface treatment amounted to 54 cents per sq. yd.

In judging this cost, it should be remembered that it is made up of a combination of construction and maintenance, that construction was complicated by a heavy traffic flow using the road, and that this traffic flow was so important that cost was not considered significant in keeping the road in service.

Had asphalt been obtainable, it is likely we would have considered the maintenance aspect only, and used some form of mixed patch, similar to hot or cold bituminous concrete. As this could not be done, we used the next best scheme possible, making use of the available local materials, our own maintenance organization, and methods familiar to our organization. Although economy was not our object, we feel the cost to be extremely low for the work accomplished, even when consideration is given to the usual cost differential of work done by contract against the actual cost of work done by a maintenance organization.

GRANULAR STABILIZED BASE CONSTRUCTION OF ACCESS AND RELOCATION ROADS BY T. V. A.

By F. W. Webster and F. H. Kellogg

General Problems. The problems encountered during the highway construction program of the T. V. A. have made those operations somewhat unique. This has been due to a number of factors, some of which fall outside the scope of this paper, but which will be mentioned to give a background of the conditions under which stabilized base roads have been built.

Most of the activities of the T. V. A. have been located in hilly or mountainous terrain, where the logical road locations follow valleys. With the construction of dams, and consequent impounding of water in these valleys, the relocated highways must either "take to the hills," or be placed on high fills which are periodically or permanently submerged. In either case, numerous problems involving slope stability, settlement, wave erosion and drainage are encountered.

Furthermore, most of the highway construction is subject to rather severe time limitations, either to provide access to dam sites as soon as possible after construction has been authorized, or to replace existing roads before they are inundated by rising reservoirs.

The regional geology of the Tennessee Valley area presents a further problem in that, in general, there are few natural deposits of granular or well graded materials. In the eastern section of the region, the large masses of micaceous schist which constitute much of the material in the Great Smokey Mountains yield highly elastic soils of the A-5 group which lose much of their strength in the presence of water. In the rest of the area, the valleys contain mostly similar materials which become progressively finer to the west, while the bulk of the other soils in the region consists of A-7 clays resulting from the decomposition of limestones and shales *in situ*. Relatively minor exceptions occur in the loess, chert and sand beds of western Kentucky and Tennessee, in alluvial deposits derived from the Cumberland Mountains and in the lower sections of large river flood plains.

The access roads to the various dams must be capable of supporting heavy loads and