REPORT OF COMMITTEE ON GRANULAR STABILIZED ROADS

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SYMPOSIUM

Applications of Granular Stabilization

SYNOPSIS

Four papers are presented dealing with the application of the principles of granular stabilization to construction of surfaces and bases. Each report introduces new and much needed information on the use of local materials. Especially noteworthy are the following items:

In his paper describing experiences at Fort Knox, Major Petty describes the successful use of 2-in. to 3-in. crushed stone to provide surfaces that would stand up under the pounding of tanks, tank destroyers, half-tracks and heavy trucks. In one case, gravel boulders up to 6-in. were incorporated in the road without difficulty.

Mr. J. Eldridge Wood describes an example of the use of local bank run gravel with calcium chloride to provide a surface for unusually heavy wartime traffic in Maryland.

Granular stabilized base construction of access and relocation roads by the Tennessee Valley Authority is described by F. W. Webster and F. H. Kellogg. It was found that the dust ratio should not exceed 0.5 if 40 per cent of the mixtures passes the No. 10 sieve, but if less than 40 per cent passes the No. 10 and the P. I. is low, the dust ratio may be up to 0.65. The finding that the liquid limit should not exceed 25 and that the plasticity index should be kept within the range of 2 to 4 is important.

Solutions of the troublesome problem caused by heavy rolling of the bottom layers of base courses containing too little moisture in order to secure the required density are presented by J. F. Tribble. In the report on mechanics of calcium chloride treatments, he describes methods of overcoming the difficulty by wetting the layer after compaction and by use of calicum chloride for moisture retention during compaction.

STABILIZATION AND MAINTENANCE OF ROADS FOR HEAVY ARMORED TRAFFIC

By Major Ben H. Petty, *Post Engineer, Camp Campbell, Kentucky*

With the coming of World War II and our preparations for and participation therein, the phrase "something new has been added" took on tremendous significance in the realm of road and street traffic in these United States. The very appreciable increase in truck loadings, the introduction of many new types of wheeled and tracked military vehicles, and the sudden ballooning of traffic volumes on roads serving military installations have generated headaches galore for street and highway engineers throughout the nation. All this, coupled with restrictions on materials, men, and equipment have combined to introduce problems never before encountered in the field of highway engineering. That traffic arteries have continued to function as well as they have is a great tribute to the engineers and officials responsible.

Particularly the ominous parade of tank destroyers and tanks weighing up to 60 tons, subjecting our roads of all types to stresses and destructive effects heretofore limited to "Buck Rogers" fantasies, have knocked many of our theories and preconceived ideas on roads into a cocked hat. When, and if we recover from the shock, the end results should be good for all concerned with highway research, design, construction, maintenance, and operation.

My comments on the subject are limited to experiences at Fort Knox, Kentucky. This is a large and important installation comprising some 106,000 acres, over 300 miles of roads, the equivalent of 100 miles of 2-lane streets on the Post proper, and 3,022,074 square yards of surfaced parking and storage areas. There are 569,867 square yards of concrete, 727,592 square yards of high type bituminous, and 3,446,676 square yards of stone streets and roads to maintain. The main range roads are of crushed limestone.

Fort Knox, having the Armored Center, Armored Board, Armored School, and Armored Replacement Training Center, is the headquarters of armored training. Thus tanks, tank destroyers, half tracks, and heavy trucks are preponderant in the traffic volume on our roads.

Fort Knox is an old Post which was expanded greatly just prior to our entry into the war. As a result, many shops and tank parks are located at various points on the Post, some being practically at its center. This necessitates tank traffic over many paved streets in going to and from driving areas and firing ranges. Possibly the resulting maintenance requirements on street surfaces, catch basin inlets, curbs, etc. can be imagined.

With the exception of a few short sections of river and creek gravel surfacing, practically all roads serving the range areas are constructed of crushed limestone. The Post Engineer operates one large quarry daily, and three smaller quarries are operated as needed. At present, three are in operation. Production runs from 500 to 1000 tons a day. Eight sizes, varying from 3 in. down to dust, are produced at the main quarry, and three sizes at another. When the other two quarries are operated, only crusher-run stone from about one inch down is produced.

Two factors explain the high demand for crushed stone. First, the destructive, grinding action of armored vehicles calls for a large quantity of replacement stone. Secondly, that reddish colored clay, so common in limestone areas, changes to a soft, sticky mess when wet, and in a surprisingly short time after a rain it is transformed into huge clouds of dust under the heavy traffic.

New roads are built of 3-in.–2-in. crushed stone, graded and rolled to proper crown, then dry-filled with screenings and rolled to consolidation. Urgency of continued use necessitated construction under traffic. Lack of equipment and time eliminated the usual waterbound construction methods. A timely rain to help consolidation was always welcomed gratefully. This was followed by an application of 1½ lb. per sq. yd. of calcium chloride which set-up and hardened the surface, without raveling, in a remarkable manner.

Tank parks and badly worn roads were resurfaced with this large stone against all my preconceived ideas of using crusher-run stone passing a 1-in. screen for such purposes. It looked bad and was bad for a few days but the tank treads performed a crusher-run operation in a very short time and if it rained during or shortly after placement of this large sized stone, the tanks coming in off the adjacent driving areas plastered enough sticky clay onto the road to fill the voids and consolidate the stone in a very short time. This could be followed by removing the surplus clay with grader blades and application of a thin layer of smaller maintenance stone, as time and availability of maintenance stone would permit.

In short, we analyzed our responsibility as that of building and maintaining a considerable mileage of scattered roads, ranges and parking areas under pressure and with limited materials, equipment and personnel to a standard suitable to keep the traffic rolling with little or no hindrance to the very important and urgent training program underway. There was no time to sit down and theorize, make elaborate test, or quibble over lack of theoretically correct materials, equipment, personnel or weather conditions. Whenever smaller sized maintenance stone was available, it was used, particularly on roads carrying mostly rubber tired vehicles.

As an example of extemporizing and economizing by "trying anything once," we resurfaced one tank road with what the average highway engineer would have classed as "impossible." At one point along Cedar Creek there is a wide flat valley of several acres which investigation revealed to be covered with 3 to 5 ft. of gravel ranging from small sandy pebbles to 6-in. boulders interspersed with a liberal amount of soil. A small power shovel was installed to load trucks and a mile or two of tank road was given a liberal resurfacing with this material, not without much misgivings on our part. It was discovered that due to the soil content and wet condition when loaded, this material set-up quickly on the road. It was necessary to keep a power grader working over it for a few days to keep it in shape so it would consolidate to proper crown and cross-section. The tanks seemed to hammer down the large boulders and a surprisingly smooth, hard surface resulted. Later this was given a thin coating of small maintenance stone. As a result of this experience, several miles of road were resurfaced with, or constructed of, this material. The haul was much shorter than from the stone quarry and there was no other relative cost than the shovel loading This represented a considerable savings in road funds.

On my arrival at Fort Knox in June 1943, I was immediately impressed by the urgent need of eliminating the dust which created not only a nuisance but also a serious danger hazard on the heavily travelled roads. A carload of calcium chloride was secured and the first application was made on the South Boundary Road which carried heavy traffic to Cedar Creek Base Camp and Battle Training Area.

The results of this application were so surprisingly good that a clamor was set up for similar applications on roads, parking areas and streets all over the reservation. Six carloads were used before the rainy season started.

During 1944 about 15 carloads were used and tank runways on the firing ranges were added to the list for applications. Calcium chloride was used also on the ground in front of the firing points for stationary tank firing to eliminate the dust raised by concussion so the targets could be readily observed.

On the range roads and tank runways a single, spinner-disc spreader mounted on wheels was attached to the rear of a stake-bodied truck for application. Two men cut open the sacks of calcium chloride and placed them in reach of a third man who dumped the contents into the hopper of the spreader as the driver controlled the speed of the truck.

Fortunately, at the time this road was treated, it was practically free of dust and the calcium chloride was applied without previous brooming or sprinkling of the surface. Applications were at the rate of 1½ lb. per sq. yd. After a short period of trial and error, we succeeded in adjusting the spreader attachment and controlling the speed of the truck such that a very uniform distribution to a width of 18 to 20 feet was secured on one trip. As the sacks were emptied into the hopper they were tossed to the roadside and an average spacing of 30 to 35 ft. between empty sacks assured the desired rate of application per square yard of surface. Subsequent applications of calcium chloride at the rate of ½ to ¾ lb. per sq. yd. followed at 4- to 6-week intervals as needed.

On some roads, where considerable dust had accumulated, a power grader was used to remove as much dust as possible and this was followed by a power operated broom, a sprinkling tank and the application of calcium chloride in close order. Prior sprinkling caused the calcium chloride to dissolve and penetrate the road surface more quickly. However, in general, there was little to choose between the results obtained by the wet and dry applications providing the surface was practically free of dust in the latter case.

Night application, when there is little or no traffic, probably would have been beneficial but this was out of the question since the workmen lived off the post up to 50 miles away and no prisoner of war labor was available at the time.

A fairly high crown is essential on calcium chloride treated roads to shed rain-water quickly and prevent the formation of surface potholes during wet weather. By blading the surface after rains when the moisture content is right, corrugations and small potholes can be eliminated. On these limestone roads, after they had dried out, the surface became so hard that the grader blade made absolutely no impression.

During 1944, on the crushed limestone streets, we used a twin-disc spreader attachment on the back end of a dump truck. The calcium chloride sacks were opened at the warehouse, the contents dumped into the truck body and hauled to the job site. When the dump body is elevated, the spreader wheels ride on the street surface and cause the discs to revolve. The calcium chloride slides through a chute to the spinning discs and is distributed uniformly as the truck speed is controlled. For short hauls this worked satisfactorily.

Another practice which was not "according to Hoyle," but which worked, may be of interest. On some of the flatter crowned streets and roads which tended to develop potholes, 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