CALCIUM CHLORIDE SURFACE CONSOLIDATED ROADS

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SYNOPSIS

This paper contains a description of the construction and maintenance methods necessary to obtain a surface consolidated road. This type of low cost road is also known, in different sections of the country, as "partial stabilization", "semi-stabilization", "accelerated traffic bound", "maintenance with calcium chloride" and "surface consolidation". Under construction are included a description of the necessary operations when (a) roads lack binder, (b) roads lack aggregate, (c) roads lack moisture, (d) new roads and (e) drainage and crown. Under maintenance types are described: Spring maintenance, Summer and Fall maintenance, hand patching and treatment with calcium chloride. The advantages of this type of surface consolidation are (1) A variety of local surfacing materials which are available in most regions can be utilized, (2) Special technical knowledge is not required in the selection of these materials, selection being based on the individual roadman's experience, (3) The cost is low, and (4) This road type fits well into a stage construction program

The surface stabilized road is denoted by many different terms—including "partial stabilization", "semi-stabilization", "accelerated traffic bound", "maintenance with calcium chloride", "surface compaction", and "surface consolidation"—depending, to a large extent, upon the section of the country being considered.

The essential differences between stabilization, as the term is commonly used, and surface consolidation are the ways in which stabilization is effected, and the depths of the respective stabilized layers. In surface consolidation, the result is attained through the use of a naturally stable material occurring either in a deposit, or as crusher run material; or the road stabilizes itself over a period of time under the action of weather and traffic; or it is stabilized through maintenance operations; while the stabilized road, so called, is designed and built as a construction project.

Calcium chloride is of value in surface consolidation because of its property of attracting and holding moisture, which has two purposes: maintenance of the natural bonding action of the binder soil during dry weather and keeping the surface sealed by expansion of the clay particles so that it will shed water during wet weather.

CONSTRUCTION

Surface consolidation operations are simple. Briefly, they consist in:

(a) Determining from field observation and experience what deficiency in material or materials causes the instability;

(b) Adding, either as a construction or as maintenance measure, suitable quantities of the materials which are lacking.

For example; if a road surface is loose and shifting, it is a clear indication that the road contains an excess of aggregate, and that it requires the addition of fine materials, binder soil, and moisture. On the other hand, it is apparent that a road having a surface which becomes slippery in wet weather contains an excess of binder soil, and that sand and, in some cases, graded aggregate are needed.

Both of the above conditions may occur on the same road. An excess of binder is often found in a cut on the top of a hill, while the surface at the foot of the hill contains an excess of aggregate. This results from the aggregate being carried

down the hill by traffic, washing, or blade maintenance.

It is apparent that these measures will not prove effective on bare sub-grades or unstable earth surfaces, since conditions of this kind call for complete construction rather than for corrective measures.

There are also large mileages of roads having proper quantities of aggregate and binder soil which need only a constant supply of moisture to make them stable. Calcium chloride, through its property of attracting moisture, is beneficial for this purpose, and should contribute to economy in maintenance.

Roads Lacking Binder. Binder soil consists either of loam or clay having some "sticky" qualities, or limestone dust Sand or silt is not considered suitable for binder. Suitable binder soil is frequently found in road shoulders or ditches.

The binder soil must be mixed with the loose aggregate before it is added to the surface of the road. Generally, traffic has worked this loose aggregate to the sides of the road; but where it has not, the loose material should be bladed to the sides of the road in windrows, so that the materials can be properly proportioned (usually one part of binder soil to nine parts of aggregate).

While the binder soil and aggregate mixture must be added to the road while the surface is wet, the binder soil is frequently bladed in from the shoulder and mixed with the aggregate windrow during dry weather.

When suitable binder soil is not found on the shoulders or in ditches and has to be hauled in, the usual procedure is to place a small windrow on the edge of the road, and to mix it with the aggregate during the dry weather. This mixture must also be added to the road when the surface is wet. In general the binder soil content will approximate 10 per cent of the total wearing surface.

When this work is carried on during the wet weather of the late fall or winter, the calcium chloride is applied the following spring while the road is still damp. When the work is performed in the spring, the first application of calcium chloride follows the final shaping.

Roads Lacking Aggregate. In selecting aggregate to be added to roads in this group, consideration must be given to the present performance of the surface under wet weather conditions.

If the road softens—forms ruts—graded aggregate should be used rather than a material of any one uniform size. Generally, this aggregate should be added to the road in several thin, uniform layers during wet weather, and over a period of time, rather than in a single heavy application. This procedure is necessary to assure (1) that all of the added aggregate will be incorporated into the surface, and (2) that no more aggregate than is necessary to accomplish the desired result is used. The roads surface may be corrected in one operation by scarifying the top inch, and adding and mixing the new aggregate with the scarified material.

If the road is compact and does not rut, but is covered in wet weather with a layer of mud due to an excess of binder soil, the application of sand, pea gravel, stone chips or similar small-sized material is recommended. This should be applied to the road surface during wet weather in very thin layers, either from trucks or by means of sand spreaders, in just sufficient quantities to blot up the mud. This work can be done in the spring before the calcium chloride has been applied, or at any time after it has been applied. When material of a granular nature is added to clay the granular material may make up as much as 80 per cent or more of total wearing surface.

Roads Lacking Moisture. Roads which are stable when damp because they already contain the proper combination of aggregate and binder soil, often lose their

binder soil in the form of dust, ravelling sets in, and "washboards" develop during dry periods. An adequate and constant supply of moisture under proper conditions of humidity may be produced by regular treatment with calcium chloride.

New Roads—Requiring Construction from Sub-grade. The three methods of obtaining calcium chloride surface consolidation, previously described, all involve the use of corrective measures. The development of a surface consolidated road on a new sub-grade is accomplished by an entirely different method, although the basic principles are the same.

When the sub-grade is of clay, a uniform layer of graded aggregate, from 2 to 3 in. thick, is placed on the prepared sub-grade, after which the road is opened to traffic Under the normal action of traffic and rain, a sufficient amount of clay will combine with the aggregate to consolidate most of the surface. When the surface has become consolidated, treatments with calcium chloride will serve to retain this condition. The few sections which do not consolidate properly should be strengthened by the addition of supplementary quantities of either aggregate or binder soil, in the same manner as the corrective measures previously described.

Drainage and Crown. The surface consolidated road, like all other types, will give more satisfactory service if properly drained.

What has been termed as the "modified A" or "straight line" crown has been found to be most satisfactory.

Lack of crown, and the resultant accumulation of surface water, will result in pot holes.

Maintenance. Due to differences in weather conditions, road surfacing materials and equipment, there is wide variance in maintenance practices on calcium chloride surface consolidated roads. However, all maintenance is aimed at accomplishing three basic things:

1. A firm and consolidated surface with a minimum of loose material.
2. Adequate crown to permit the rapid run-off of surface water ($\frac{1}{2}$ in. per ft. or 5 in. for a 20-ft. roadway).
3. Presence of enough calcium chloride to maintain the road surface in a moist condition.

Spring Maintenance. The annual spring maintenance consists of.

1 Shaping the road to restore the proper cross section. This means building and re-aligning the crown.
2. Addition of binder soil and aggregate where required.
3. The adding of calcium chloride, following spring rains and before the road is completely dry

It is very important that patrolmen take advantage of the early spring period to bring the roads up to ideal shape and smoothness, as this early maintenance will be directly reflected in an improved surface and in less maintenance during the months which follow. If the spring maintenance is done thoroughly, no further heavy maintenance will be necessary until the final shaping in the fall.

Summer and Fall Maintenance. During the summer and early fall seasons, the maintenance is limited to light blading of the surface. It is recommended that the patrolmen take advantage of rainy periods and start their maintenance either during or immediately following a rain. This maintenance consists of lightly blading from the edges toward the center of the road and then reversing the operations, feathering the material to the edge of the road. Care should be taken to maintain only a section of such length that it can be compacted before the road surface becomes too dry to bond under traffic. It is generally not advisable to blade the surface of consolidated roads during dry weather, as this tends to

loosen the aggregate and dissipate the calcium chloride.

Hand Patching. During prolonged dry spells, if maintenance becomes necessary, hand patching may be used. It is the practice to square the sides of pot-holes to the greatest depth of the hole. The hole is then filled with a mixture of graded aggregate, binder soil, calcium chloride and water, of such a consistency that it will bond to the old material when tamped into place. Suitable patching mixtures will contain approximately nine parts of aggregate to one part of binder soil, together with calcium chloride at the rate of 15 to 20 lb. per cu. yd. of stabilized mixture.

Treatment of Calcium Chloride. A surface treatment of calcium chloride at proper intervals is a primary maintenance operation. The first application is usually made following the spring rains and while there is still evidence of moisture in the road material. Subsequent light applications should be made during the summer months whenever the surface begins to show signs of drying or dusting.

It can be seen that considerable responsibility for the maintenance of calcium chloride treated roads rests with the foreman or patrolman, who sees the condition of the road every few days. A small amount of maintenance at the proper time will save extensive maintenance at a later date.

CONCLUSIONS

The advantages of this type of surface consolidation are:

(1) A variety of local surfacing materials which are available in most regions can be utilized.
(2) Special technical knowledge is not required in the selection of these materials; selection being based on the individual roadman's experience.
(3) The cost is low.
(4) This road type fits well into a stage construction program.

DISCUSSION ON CALCIUM CHLORIDE SURFACE CONSOLIDATION

MR. F. P. G. HALBFASS, *Muscatine County, Iowa:* As the result of observations on two stabilized soil-aggregate wearing course projects (Table 1) constructed over a year ago we have arrived at the following conclusions concerning this type of work:

1. A soil survey should be made of the area to be covered and all undesirable material removed prior to construction.

2. A crown of at least one-half ($\frac{1}{2}$) in. per ft. of width is desirable.

3. Stabilized soil aggregate wearing courses should be approximately four inches in thickness.

It is desirable to thicken the edges of both stabilized base and wearing courses 3 or more inches.

4. The incorporation of $\frac{1}{2}$ lb. of calcium chloride per square yard of area per inch of thickness of stabilized mixture is recommended for both base and wearing courses. Surface application of calcium chloride should be made on stabilized wearing courses soon after completion of construction.

TABLE 1

Length	Area	P I.	Thickness
ms.	*sq yd.*		*in*
6 6	90,374	8	$1\frac{5}{16}$
1 4	19,712	10	3

MR. W. T. VAN AUKEN, *DeKalb County, Indiana:* Surface consolidation experiments have been conducted on two projects of two and one-half and one mile in length respectively. In view of the

volume of traffic (approximately 500 vehicles per day) these experiments were undertaken with the view to minimizing blading and gravel replacement expenses.

On one road binder soil was lacking, while on the other section it proved desirable to utilize a source of bank run gravel and add binder soil. In the former case the roadway was scarified to a depth of 4 in., all oversize aggregate removed, and binder soil added at the rate of 40 tons per mile. In the latter case bank run gravel and binder soil were mixed in the proportion of 300 tons of bank run gravel to 30 tons of clay binder soil per mile. Mixing and shaping was accomplished by the use of power graders. Following shaping the roads received an initial application of calcium chloride at the rate of 6¼ tons per mile. This initial treatment was followed by light applications of 2½ and 1¼ tons per mile in the summer and fall respectively.

Daily blading has been necessary on common gravel roads to maintain any degree of smoothness. From the economic standpoint, therefore, the roads selected for the study, which were formerly of this type, permit of direct comparison. Typical annual maintenance expenditures on our common gravel roads have approximated $300 per mile for materials replacement and blading operations. Contrasted with this experience is the fact that thus far on the calcium chloride surface consolidated sections, blading costs have been reduced by more than 90 per cent and gravel losses have been nil. Present plans call for surface consolidation of at least 15 miles of gravel roads during the 1941 construction season.