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New Hard Surfaced Floors for the Farm Poultry House

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FOR

The Farm Poultry House

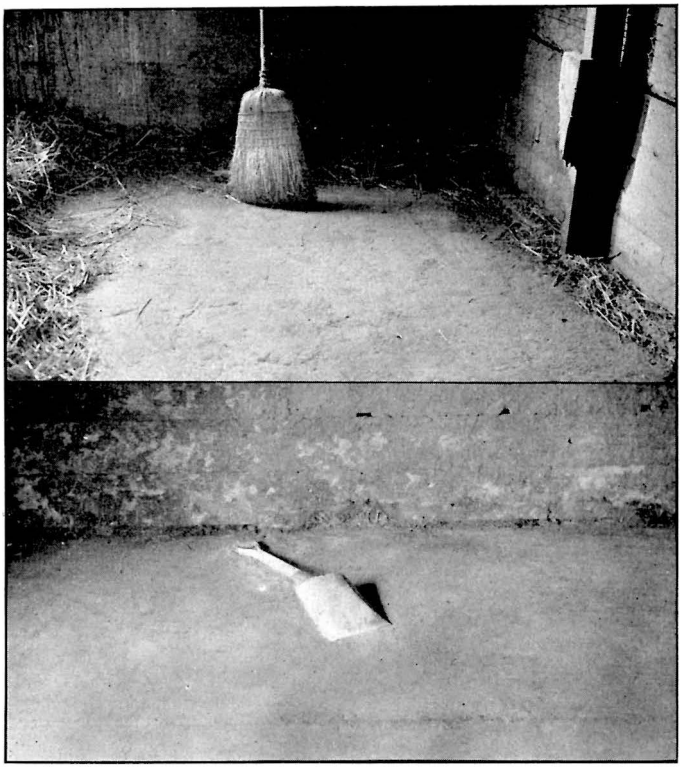

Fig. 1. Two Inexpensive Floors Which Are Easy to Build on the Farm

The top floor is an oil-surfaced floor—a new type developed by the South Dakota Experiment Station, Department of Agricultural Engineering for poultry houses. The floor had been in use for 2½ years under poultry.

The lower picture is of soil-cement—a new light traffic highway surface. It had been in use under feeder steers for one year when the picture was taken.

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New Hard Surfaced Floors for the Farm Poultry House

Ralph L. Patty and L. F. Larsen[1]

Experimental work on poultry house floors by the Agricultural Engineering department of the South Dakota Agricultural Experiment Station has developed two new hard-surfaced floors that are very practical for the purpose. One is of soil-cement and the other of oil-surfaced soil mixture. Their principal advantage is their low cost. Cost of materials for these floors figures about one-third that for the conventional concrete floor. The time required to build them is about the same, and even with hired labor the total cost of building these floors should be only one-third as much as for concrete or even less.

For many years there has been a demand for an inexpensive hard-surfaced floor for the poultry house; one that also would be easy to clean and disinfect. This experimental work is being done as a result of this demand. Ten different floors are under test in a 20 x 60-foot poultry house that is being used for housing turkeys. All of these floors have been used for two full years and some of them are three years old. They have been thoroughly cleaned at regular intervals and scrubbed and disinfected at least twice each year at which time they were given careful inspection. A conventional concrete floor and one of cinder-concrete were included in the floors under test for comparison with the new types. This comparison was made on the cost and construction methods as well as on the servicability and durability of the floors. The floors were of the same size and have been subjected to the same use and treatment. Some of the other floors are proving to be satisfactory in use but are not so practical at this time, either because of difficulty in construction or because the materials are not readily available, or both. The following list of floors together with the cost of materials for building them were included in the test and are listed below:

Type of Floor	Cost of Materials For 100 Sq. Ft.	Type of Floor	Cost of Materials For 100 Sq. Ft.
Sawdust-cement Concrete	$11.10[2]	Tar, Oil-gravel	$2.00
Common Concrete	6.35	Asphalt, Oil-gravel	2.00
Cinder-concrete	6.35	Raylig (lignin)	1.61
Stabilized Adobe	5.00	Oil-surfaced Floor (3¼")	1.26
Soil-cement	2.26	Oil-surfaced Floor (5½")	1.26[3]

In addition to the inside floors, similar test floors of the most promising ones have been built outside, in order to determine their resistance to extreme

1. The authors wish to acknowledge the aid and cooperation of Professors W. E. Poley and W. O. Wilson of the Poultry Husbandry department in advising and aiding in the inspection of the floors used in this project.

2. For sawdust-cement floor 400 lbs. of white pine sawdust cost $4.

3. This floor cost no more for materials than the 3¼ inch oil-surfaced floor because soil-mixture only, was used for the extra layer. The cost of the oil in 1940 was 14 cents per gallon (barrel returned). The price has raised somewhat since.

weather conditions. The soil-cement and oil-surfaced floors described in this publication also have been tested under fattening steers both inside and outside the shed. This was done with the expectation that their resistance limit would be reached and could be measured. The oil-surfaced floors failed in a very short time but the soil-cement floors are still standing in good condition. Neither of these floors would be recommended for use under fattening steers but they have proved satisfactory in poultry houses and as the foregoing figures show, they are inexpensive. In addition, they are not hard to build and do not require special equipment, except for the floor rammer which is standard equipment for a concrete contractor and can be bought at any hardware store.

The Soil-Cement Floor

The soil-cement floor was suggested by similar hard-surfaced roads that are being tested by the Federal government and by highway men of several states. After several years trial the reports are quite favorable for light traffic highways built in this manner.

The soil-cement floor is made by adding 10 percent of Portland cement to the top layer of a good clay-gravel mixture of soil packed thoroughly in place. The floor is built in two layers. The bottom layer is rammed with just the right moisture to make it pack well but contains no cement. It is one and three-fourths inches thick when packed. The top layer is made out of the same mixture of soil except that it should contain no coarse gravel. To this is added 10 percent of Portland cement (1 shovel of cement to 9 shovels of soil-mixture) and it is one and one-half inches in thickness after being packed. This makes the total thickness of the floor three and a quarter inches. In order to have a good smooth floor it is necessary to use forms and lay the loose material down evenly before ramming. It is best to build it in strips between two-inch forms in the same way as for concrete floors. In building highway surfaces of soil-cement the moist material is packed by heavy rollers. In building poultry house floors the heaviest hand rollers are unsatisfactory because they do not pack sufficiently and it is necessary to pack them by means of floor rammers.

Floor Rammers.—Two sizes of floor rammers are desirable but there is one size that can be used satisfactorily for the entire job if it is desired to avoid the purchase of two. This rammer should be a heavy 6 x 6-inch rammer with a total weight of 20 to 25 pounds. (See Fig. 2.) When two rammers are used, one should be 10 x 10 inches square and may weigh 15 to 20 pounds while the other should have a small rammer head of 3½ to 4 inches square weighing 12 to 17 pounds. This small rammer will pack just a little harder than the large ones, but the large ones are better for going over the first time and for smoothing or finishing the top surface.

The work does not go fast but it can be done a portion at a time if necessary. Two men should build a section of floor 12 x 20 feet in 10 hours if the material is on hand. For inexperienced workmen it would take just as long

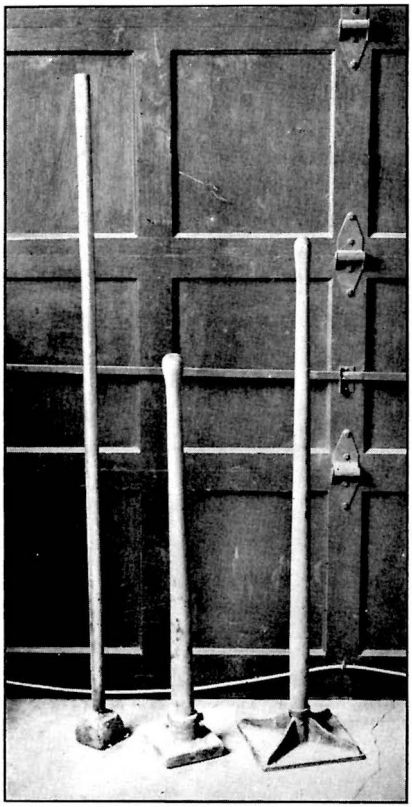

FIG. 2. FLOOR RAMMERS FOR MAKING FLOORS.

Two rammers are best for building these floors, the small rammer at the left in this picture and one of the larger ones. The larger rammer is better for going over the loose material the first time and for smoothing the top surface in finishing the floor. A stroke of the small rammer with average force will pack harder than the same stroke with the larger rammers. The medium-sized rammer in the center would pack hard enough for poultry floors and the entire floor could be made from it. The small rammer weighs 14 pounds, the center rammer 21 and the large rammer on the right, 16 pounds.

to build the same floor of concrete. As indicated above, these new type floors are developed for the person who has little money to invest and who is willing to do a little extra work in building a high quality hard-surfaced floor for himself.

The preceeding discussion on packing the soil-cement floor applies also to the oil-surfaced floor. In building the oiled-gravel or "black-top" hard-surfaced highways the packing is done by heavy rollers. Extra heavy hand rollers were tried in making poultry house floors of this "black-top" material also, and the results were not satisfactory. The floor rammers do an excellent job and the hand rammers are better than mechanical rammers for the purpose, especially for finishing the surface.

The Soil Mixture for Soil-Cement

The soil mixture used for soil-cement floors is almost a gravel or sand, but it should contain about 25 percent of silt and clay. The rest should be sand and gravel. A sandy subsoil might be satisfactory just as it is dug up in some localities, but generally additional sand will be needed to make the 75 percent sand. The color of the subsoil makes no difference; it may be black, yellow, or red. It may not seem to contain clay but it is apt to contain a sufficient amount. The average clay subsoil (6 inches or more below the surface) contains from 35 to 40 percent sand. When this is mixed with an equal amount of bank-run gravel the mixture will be just about right. This example is for the average subsoil. For soil, generally the variation is great. It is safer not to use the top soil. The top six inches of soil may contain injurious organic matter.[4] Coarse gravel is used only in the lower or base course of the floor and there is no advantage in using it at all except to save screening it out. For the top course, the coarse gravel should be screened out and only the sand (through a one-fourth inch screen) should be used; but the ratio of sand and clay should be the same. A light sandy soil will be entirely satisfactory for making this type of floor. Fine sand in the soil is even better than coarse sand and almost any light soil will contain enough clay and silt, although it may not show it. The majority of soils will need an addition of from one to five shovels of sand for each 10 shovels of soil.

Testing The Soil.—The soil or subsoil that is to be used should be tested before mixing it with the gravel or sand, in order to find out the proportion of gravel that should be added in order to get the 75-25 percent mixture. In making a test of the soil it is important, of course, to get a uniform sample as it is going to be used. There are two ways of getting this test. One is to make a home test of the subsoil which is described on page 23 of South Dakota Extension Circular No. 362. The other method is to send a sample of the soil in to the Department of Agricultural Engineering, State Experiment Station, South Dakota State College, for analysis. When a laboratory analysis of the soil is made, the exact measures for mixing with gravel for the highest quality floor will be furnished. Before obtaining the sample of subsoil for sending into the laboratory, it is best to secure an instruction sheet which is available from the department containing directions for taking and sending the samples.[5]

The Proper Moisture.—The moisture in this soil-mixture should be the same as the optimum moisture for making rammed earth walls in order that it will pack firm and hard. The test for the right moisture is also the same. Following are three easy tests that are used to identify proper moisture in the

4. The Portland Cement Association has done extensive research on this subject in connection with soil-cement highway surfaces.

5. The charge for making the laboratory soil analysis is $1.00 for builders in South Dakota and $2.00 for builders outside the state.

soil. These were the only tests used in experimental building described in this bulletin. Laboratory tests for moisture were purposely avoided.

(1) The soil-mixture should be moist enough to mold in the hand when squeezed, but not quite moist enough to make a mud ball.

(2) When it is rammed with a steel rammer head it should bother a little by sticking to the rammer, but should not be wet enough to become too spongy to ram down solidly.

(3) After a handful of soil has been squeezed and molded in the hand and it is dropped from the waist line onto a hard floor it should break apart.

With these three tests for proper moisture in mind there is no danger of mistaking it, and, after a little practice, the bottom of the rammer head may be covered with a piece of old inner tube from an automobile tire (See Fig. 16) to prevent the soil from sticking to it. The practice is well worth while as it saves considerable time.

Time will be saved and a harder floor secured also if the soil before use, is kept moist. When it is too dry, it is hard to get the moisture evenly distributed through it and the mixture will not pack as well. If the soil gets very dry it will pay to spread it out and sprinkle it good with water, mix it well and pile it up again. In two or three days the moisture will spread through it again. In average weather, the moisture in the soil will be just about right as it is dug up, when mixed with dry sand. Soil that is too wet can be spread out and turned for drying.

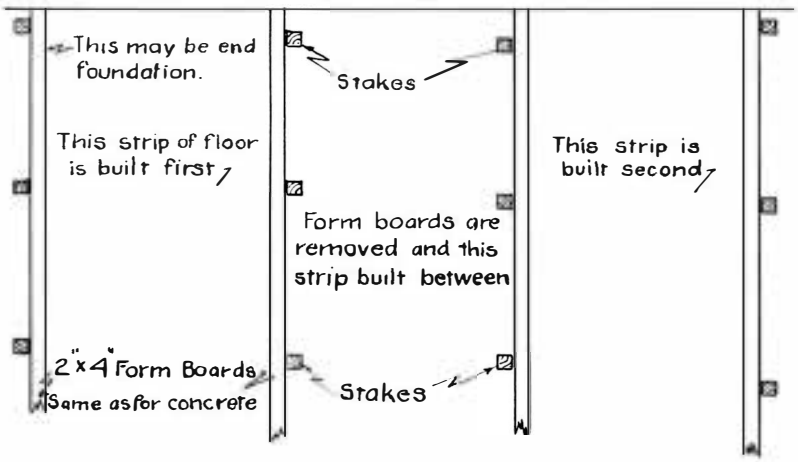

FIG. 3. METHOD OF SETTING FORM STRIPS FOR BUILDING EITHER OF THE FLOORS.

The 2 x 4-inch strips are staked as shown above. In starting to build the floor one or the other outside strip would be against the foundation and the form strip would not be used. The depth between the strips should be 3¼ inches as shown in Fig. 3.

How to Build Soil-Cement Floors—in Detail

Before starting to build this floor it should be decided where the top of the floor should come, and fill or excavation made, allowing three and one-fourth inches for the thickness of the floor. It is good practice to have any floor raised from 6 to 12 inches above the general level of the ground outside the foundation. If a fill is to be made of soil only, it is an advantage to make it several months before the soil-cement floor is to be built to allow time for settling. If at all possible, this soil should be moist and packed some as the fill is made. The packing may be quickly done with a tractor or truck if the fill is made just after the concrete foundation is finished and before the poultry house is built. The corners will have to be packed by hand, of course. Coarse gravel and coarse cinders make a good material for filling under a floor but enough soil must be used in the top layer so it will pack well. If the building site is not on a high well drained location, coarse gravel is necessary for this fill.

The Sub-Base.—The method used for preparing the sub-base and setting the forms is the same as is used for pouring concrete floors. The same amount of work is required. The sub-base is roughly prepared by excavating or filling as needed and roughly packed. The floor is best made in strips having a width that is most convenient for the work. This width should be around six feet. For poultry house floors 2 x 4 inch lumber placed on edge should be used for the forms. These are staked down and carefully leveled with a carpenter's level on a straight edge (same as for concrete) so the finished floor will have the correct slope toward a drain or toward the door. As the forms are staked in place and nailed, they should be settled slightly as the thickness of the floor is to be only 3¼ inches. The 2 x 4 pieces are 3 5/8 inches wide.

It is extremely necessary to have this sub-base reasonably level and firm before starting to build the floor. As soon as the side forms are in place, the sub-base between should be given a final packing as the surface is leveled. The final leveling should be done with a template board similar to the one shown in Fig. 4 except that the depth of the notch should be 3¼ inches instead of 1½ inches as shown. This makes two templates that should be used in building the floor. In leveling and ramming the sub-base between the forms, it should be kept in mind that the soil probably will ram down from one-half to three-fourths inches thereby increasing the depth between the form boards which should finally be very close to 3¼ inches. The reason for having the sub-base reasonably level is because this is the way to make the top of the floor level. It is even important to spread the loose material in the forms with shovels in order to have the floor build up to a uniformly smooth surface. If material is dumped from a wheel barrow it should be shoveled over slightly to avoid a high point in the floor due to the material packing from the fall. Those who are experienced in dumping gravel will understand why this is important.

Staking the Forms.—In staking down the 2 x 4-inch form strips, good solid stakes should be driven 24 inches apart and along the outside. There is heavy pressure against these forms due to the ramming. The inside of the form

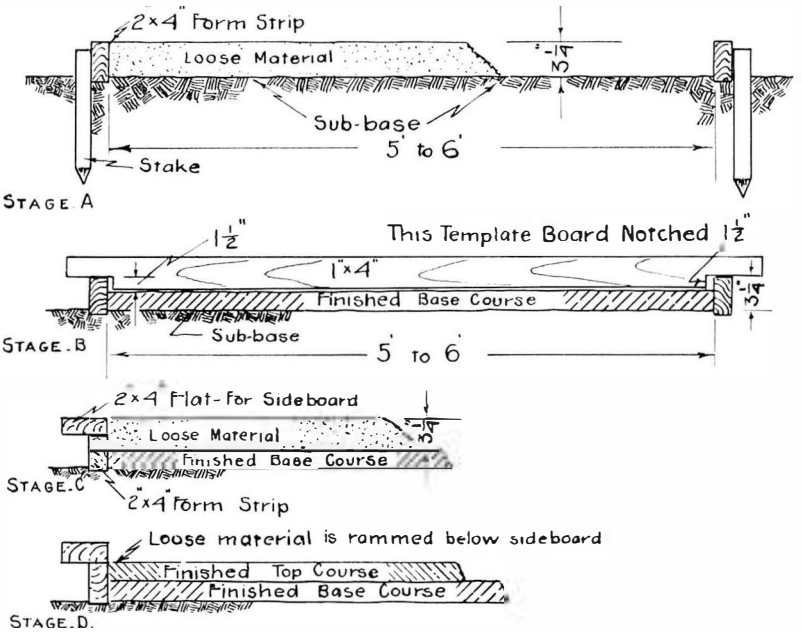

FIG. 4. SHOWING THE FOUR STAGES IN BUILDING THE FLOORS.

Stage A shows the finished sub-base with the loose soil-mixture in the forms and ready to ram down for the base course. **Stage B** shows the finished base course after it is rammed in place. The template is shown in place for checking the remaining 1½ inches that should be left between the form strips. **Stage C** shows one edge of the form upon which side boards have been built to hold the loose top course material. A 2 x 4-inch laid flat and nailed is used for the side board. **Stage D** shows the top course after ramming. The top course should ram down about even with the original form strips and the side board may be removed.

should be kept clear for the strip of floor being built. It is very necessary to use form strips and carefully strike-off the loose material in order to get a smooth floor. The width of the strips does not have to be exactly six feet but this is a convenient width. If the same width is used for all strips it will help in gauging the amount of top mixture to prepare for each batch and the template boards will fit.

Mixing and Placing.—The proper subsoil and gravel mixture which has been referred to as "soil-mixture" has already been discussed but the method of mixing it has not. Even light soils are apt to need some additional sand added to them and this is best done on a mixing board made for the purpose, or it may be done on a concrete or wood floor in an adjacent building if it is close enough. After mixing, it may be moved in place with a wheel barrow. In order to avoid building a mixing board, the first strip of floor might be allowed to cure for a week and then used as a mixing surface for the rest of the floor. A smooth place on the ground can also be used for mixing, al-

FIG. 5. USING A CONCRETE MIXER FOR THE BASE COURSE.

A concrete mixer is not satisfactory for mixing the top course of the soil-cement floor. It can be used for mixing the base course of either floor if the soil contains about the right moisture before the soil and sand are shoveled into the mixer. On small jobs it may not pay to use it.

though it is not quite so convenient. If a laboratory soil analysis has been made of the soil, the builder would now know exactly how many measures of sand should be added to the subsoil for the soil-mixture in order to have the very best floor. These materials are best measured as they are shoveled onto the mixing board. If one shovel of sand was to be added to each three shovels of subsoil, he should count the shovelfuls as they are being shoveled onto the board or shoveling surface. A certain amount of mixing can be done as they are shoveled onto the board but the material should be turned two or three times in addition until it is well mixed. If the soil is too dry, some moisture can be added (only by sprinkling) as this turning is done. For the bottom course, the mixture will now be ready to spread in the forms and ram in place. The mixing of the first few batches at least, should be done by hand. If a concrete mixer is available it may be used for mixing the lower course soil-mixture, but the top course containing the Portland cement is best mixed by hand.

Packing The Layers.—If two rammers are used the large flat-faced rammer should be used the first time over for the loose layer and the small-faced rammer should then be used about twice over. Small-faced rammers are slightly better to use for the main part on both courses because they pack harder. Two times over with a fairly sharp ramming stroke will be sufficient. The rammers should not be more than 4 inches square and they should weigh approximately 14 pounds. (See Exp. Sta. Bul. 277, p. 10).

The Lower Course.—After twice over with the small rammer the lower course will be rough on top which is probably best, but it should also be level within one-fourth inch throughout. It should also be almost exactly one and one-half inches below the top of the form strips. The template (See Fig. 6) is made for checking both depth and level. If the high spots can-

not be brought down to proper level by ramming, it is possible to trim the high points with a sharp spade. This should be done before the loose material for the top course is laid down.

When the surface of the lower course is made to check with the template, this course is finished. A 2 x 4-inch strip is now laid flat on top of the other form strips to form side-boards so as to make the right depth of loose material for the top course (See Fig. 4). If this depth is right the floor will ram down even and level with the bottom form strips. These flat strips can be quickly nailed down to the lower ones with 10d wire nails spaced about 36 inches apart. The form is now ready for the loose top layer. Before placing the top course, the surface of the lower course is sprinkled with water so the two will bond together.

The Top Course.—The top layer is made of the same soil that was used for the bottom layer but 10 percent of Portland cement (by measure) is added to it. One measure of Portland cement is mixed with nine measures of the soil-mixture. The cement and soil-mixture should be mixed together thoroughly before any additional water is added. Hand mixing brought better results than use of a concrete mixer for top course material. A 70-shovel batch of top mixture seems to be a convenient-sized batch to mix up at one time. This will be made up of 63 shovelfuls of the soil mixture and 7 shovelfuls of cement—making 1 shovelful of cement to each nine shovelfuls of soil. In mixing with shovels, reasonable care should be used to get the shovelfuls the same size. Coarse pebbles larger than one-fourth inch should be screened out. If a large pebble came in the surface of the floor it might loosen later, leave a hole in the surface and hasten deterioration.

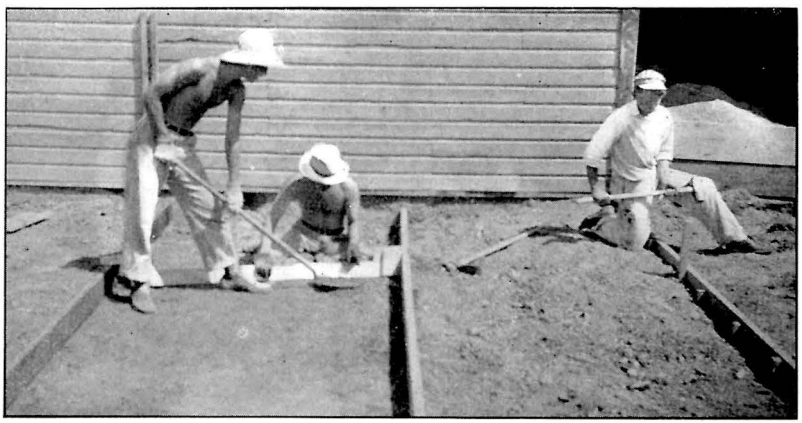

FIG. 6. PREPARING THE SUB-BASE AND CHECKING THE DEPTH.

When the sub-base is settled with the rammer the depth between the form strips should be 3¼ inches. The two men on the left are checking this depth with a template board that is notched for that depth.

After the cement is added and mixed in with the soil it will be necessary to add considerable more water to the mixture because the dry cement will absorb it. On the first batch it is advisable to try an additional measured amount and make it just a little wetter than the bottom layer seemed. If it rams down solid it is not too wet, and if it does not stick to the steel rammer head it is too dry. The same test methods used for the bottom-course mixture should be used for this top course. It is important to have enough moisture. If the top course is too dry, a poor floor will result. One man should check all batches of moisture until the crew becomes experienced with it. It must be remembered that only small batches of the top course can be mixed at one time because of the cement. When the cement comes in contact with moist soil it soon begins to set-up. Only batches that can be rammed in place within the hour, or possibly one and one-half hours should be mixed at one time.

The surface of the bottom course should be sprinkled fairly heavily with water just before spreading the top course in the forms. The water should not stand on top but the surface should be thoroughly sprinkled. A hose using a light spray is best but a garden sprinkling-can or a can with very small holes punched in the bottom is satisfactory for the purpose.

Now, the mixture for the top course is spread evenly in the form and rammed to finish the floor. The loose material is first struck-off level with the top of the form strips by using a sawing motion of the straight-edge or template. Only about six feet of length in a floor strip should be tried for the first time because it should be rammed twice over with the small rammer and twice with the large one before the cement begins to set-up. A 70-shovel batch is about right. If the one 6x6-inch rammer is used, the layer should be

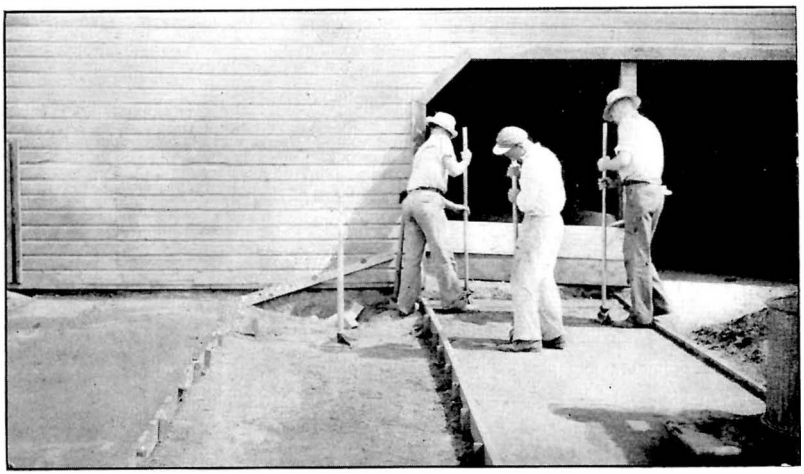

FIG. 7. BUILDING A SOIL-CEMENT FLOOR.

The floor is built in strips the same as for concrete. The outside strips are built first. The forms are then removed and the strip between is built. The strips should be the same width so the templates will fit. A width of 5 to 6 feet is best.

FIG. 8. STRIKING-OFF THE LOOSE SOIL-CEMENT MIXTURE BEFORE RAMMING IT FOR THE TOP COURSE.

The back of the template board can be used for this purpose if it has a straight edge. Note the 2 x 4-inch laid flat for the side-boards. When this is rammed down the floor is finished. See Fig. 7.

gone over at least four times, lapping the strokes slightly. The 70-shovel batch will make a top strip of floor about six feet square. Another batch is then mixed and placed in the form and rammed down.

The loose top-course material between the form strips cannot be rammed to the very edge for each batch, because the edge will flatten or "feather-out" unless a stop-board is put in to hold it. While working right along it is best to ram up to about two feet from the edge and then mix another batch and put it in the forms and continue the ramming. The extra 15 minutes required to mix up the next batch will not hurt the edge of loose material that has waited this long for ramming. In quitting work at noon or at night it would be impossible to leave this edge unrammed for so long a time. The cement will set up and spoil. So it will be necessary to put a "stop board" in the form and ram all of the loose material that has been mixed with cement (See Fig. 9). This stop board will need one stake in the center and nails or stakes at each end to hold it in place. When a stop board is used a joint will be made in the floor and when the work is continued some care must be used to get the surface smooth at this joint.

Curing the Soil-Cement Floor

After the floor is finished it should be allowed to cure the same as a concrete floor. It should be kept moist for two or three days or a week if possible. Probably the best way is to sprinkle it and then cover it with soft moist dirt. If the floor is inside the finished building it might be kept moist for a day or two and then covered with newspapers or straw to retard the drying out.

If the floor is allowed to dry and cure too fast the cement and sand do not set properly and the surface will not be tough and resistant to wear. There is little danger in keeping it too wet by sprinkling especially for the first two or three days. If the house is built, the closing of doors and windows will help prevent too rapid drying out.

The Template Boards

Use of template boards for leveling the surface in building either of the floors is quite as important as for concrete work. Two templates are used as mentioned above. One has notches 1½ inches deep and the other one, which is used for leveling and gauging the depth between the forms before the floor is started, has notches 3¼ inches deep. The use of the templates is shown in the pictures. In making the templates two things should be kept in mind. The top or back of the template should be straight so that it may be turned over and used as a straightedge in striking off the top loose layer. Secondly, the notches should not be sawed to fit snugly between the form boards but rather about a half inch of play should be allowed to allow for a sawing motion in in striking-off.

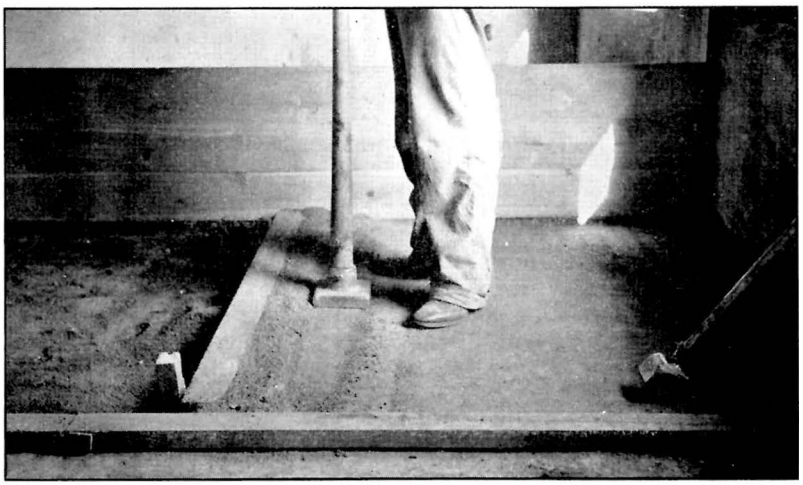

FIG. 9. FINISHING THE SOIL-CEMENT FLOOR.

The loose top course is first gone over once lightly with a large or medium rammer. It is then gone over sharply twice, with the small rammer at the right and finished smooth with the large or medium rammer. The worker in the picture is using the medium sized rammer. The stop board which is mentioned in the instructions is shown. A 2 x 4-inch piece laid flat does nicely. The stop board is used only when the work is stopped for an hour or more which would allow the cement in the soil-mixture to set up and spoil.

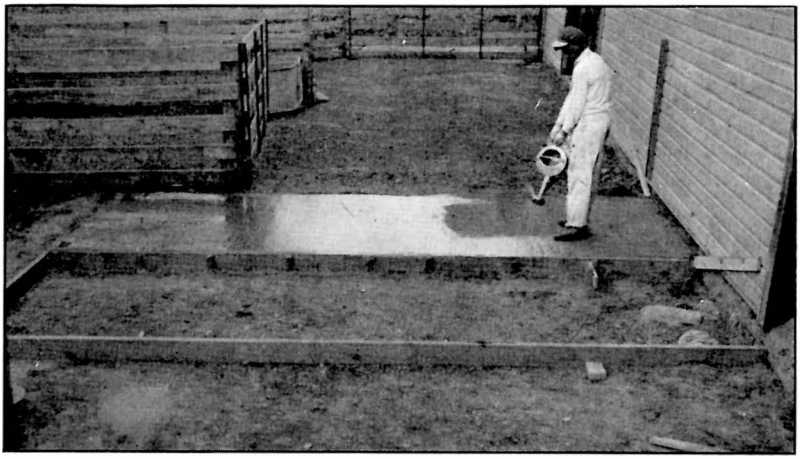

FIG. 10. CURING A SOIL-CEMENT FLOOR BY SPRINKLING.

The soil-cement floor should be cured the same as for concrete. Keeping the surface damp for two or three days at least is necessary to securing a tough and resistant floor. A sprinkler can be made by punching small holes in an old pail or large can. Unlike concrete, this floor can be walked on immediately.

Use of a Concrete Mixer

A concrete mixer can be used for mixing the base course of either floor since the base course is the same. Of course it would not be needed if the soil already contained enough sand. For a small job it may not pay to set one up, but an experienced man doing custom work could save some time in using a mixer for these floors. If a mixer is to be used, dry soil first should be moistened. The soil and sand may then be shoveled into the mixer and mixed the same as concrete. If only a trace of additional moisture is needed it may be added by sprinkling while the mixer is running. Water cannot be thrown into the mixer as is done in mixing concrete. This will result in wet balls of mud and in weak spots throughout the finished floor. The top course for soil-cement cannot be mixed satisfactorily by machine. It is impossible to secure an even distribution of the cement throughout the soil-mixture.

In Building the Soil-Cement Floor, This List of Operations, if Tacked Up on the Poultry House Wall, Will be Found Useful.

Materials and Equipment Needed

Soil and extra sand—2 yds. per 100 sq. ft.
Portland cement—3 bags per 100 sq. ft.
Mixing floor or space
2 x 4-inch form lumber
Floor rammers—one or two
Spade and shovels
Carpenters square, saw, etc.
Template boards—two
Sprinkling cans for water
Stop-board (See Fig. 9)

1. A 3¼-inch thickness is allowed for a poultry house floor and the space for it should be leveled off and firmly packed.
2. A light sandy soil is then mixed with enough bank-run gravel to make the total sand and gravel equal about 75 percent of the soil-mixture. (This is the same mixture as is used for the highest grade rammed earth wall.) Moisture is added as the sand and soil are mixed together.
3. Forms are made of 2 x 4-inch boards staked down on the outside, so as to build a 6-foot strip of floor across the short way of the house at one time. The 2 x 4-inch form strips are settled enough to leave exactly a 3¼-inch depth inside. (See Figs. 3 and 4.)
4. The moist mixture of soil and sand is spread evenly between the form boards and struck off level with the top of the form boards by means of a straight-edged board. The back of the template board (See Fig. 8) may be used for this.
5. This layer of loose material is then rammed once over with a large flat-faced hand floor rammer, a tool often used by concrete contractors in building sidewalks. (See Fig. 2.)
6. It should then be rammed sharply twice over with a small-faced steel hand rammer 3 to 4-inches square that is used for making rammed-earth walls.
7. This course may be left rough on top, but it should be level or the finished floor will not be level. The ramming should leave this surface almost exactly one and one-half inches below the top edges of the form. The template (Fig. 4) should be used for checking this depth and leveling the surface.
8. Two-by-four strips are then laid flat and nailed on top of the forms to make a total depth of the form for the loose top course 3¼ inches. (See Fig. 4.)

9. To the same loose mixture that was used for the lower course of the floor, is now mixed 10 percent of common Portland cement by volume (1 shovel of cement to 9 shovels of soil mixture). Some additional moisture must be added because the dry cement absorbs considerable water. This mixture for the top course should be fully as moist if not a trifle more than for the base course. Only as much top course material should be mixed at one time as can be rammed in place within one hour.

10. The surface of the base course is then sprinkled for receiving the top course.

11. The mixture for the top course is now spread evenly in the form with a shovel and struck-off level with the forms the same as for the first layer. It is then gone over once with the big floor rammer, twice with a small-headed rammer and then smoothed out on top with the big rammer again. The floor is then finished, except for curing. If a 6 x 6-inch rammer alone is used it should be gone over four times with sharp strokes.

12. In curing, the surface should be sprinkled with water every two or three hours for the first day or two if it is under cover and if outside still greater care should be used to keep it from drying out.

The Oil-Surfaced Floor

Oiled-gravel floors that are made like "black-top" hard surfaced roads have not been very popular for farm poultry houses because they are hard to build. In the first place the heavy oil that is used in them must be heated. This is not easy to do on the farm. In the second place the methods used for mixing, spreading and packing the highways cannot be used in building inside floors. The problem was to develop a new, simple method of building an oiled floor that would be practical for the farm. This was done by using a light or thin rapid-curing oil that did not require heating before use; by sprinkling the oil on the surface of the loose soil to get good penetration; and by tamping the material in place instead of packing and rolling it as is done in highway building.

The oil-surface floor is built so nearly like the soil-cement floor that many of the instructions for building are the same. In the first place the soil mixture is exactly the same as for the soil-cement floor. It contains about 75 percent sand and 25 percent clay and silt. The same test of the subsoil to which sand was added is used for the oil-surfaced floor. The coarse gravel is left in the base course, but for the top course the material is all passed through a one-fourth inch screen. The moisture content is the same and is identified in the same way. The filling and grading is done in the same way and the same forms are used and in exactly the same way. The same two layers of floor are used and with the same dimensions.

The difference in making the two floors is that instead of mixing Portland cement with the loose top-layer of floor, cut-back asphalt oil is used.

The difference in building the oil-surfaced floor from that of oil-gravel or "black-top" highways is that, instead of mixing the oil with the loose soil before placing, the oil is sprinkled on the loose top-layer in place—which it penetrates. It is allowed to dry for at least 18 to 24 hours and is then packed with the hand rammers.

How to Build the Oil-Surfaced Floor

After the filling, grading, and forms are completed, as before described for soil-cement, the lower course of floor is mixed and rammed in place between the forms in the same way. (See pages 8 to 10.) The thickness of this lower course is the same. The shallow template is then used for gauging and trimming the surface of this lower course, leaving it rough but level. The 2 x 4-inch strips for sideboards are then laid flat around the form strips and nailed down. Before the loose layer of top course material is placed, a primer coat of cut-back asphalt oil (described later) is brushed over the sur-

face of the lower course at the rate of six quarts of oil to 100 square feet of surface. This is sprinkled on and brushed out with an ordinary long-handled scrub brush.

The soil-mixture for the top course is the same as for the lower course except that it should contain no pieces of gravel larger than one-fourth inch. There is no advantage in having coarse gravel in the base coarse except to save screening. The ratio of sand to clay and silt is the same. If there are no pebbles in the soil-mixture the same pile of soil may be used for the entire floor. A little study of the most convenient system in preparing the soil-mixture will save considerable time in building either type of floor. The loose soil-mixture is now placed in the form and struck-off smooth and level with the top of the forms by using the back of the template for a straight-edge. This layer of loose material will be 3¼ inches deep and is now ready for the filling oil.

A cut-back asphalt oil is used for this purpose. This oil is substantially the same as type RC-2 road oil and is light enough to use as a seal coat for bituminous or "black top" road surfaces although RC-1 oil is still lighter, and is generally called "seal coat" oil. It is more commonly known as "cut-back asphalt oil—cold mix."[6] It is a black oil but is thin or light, and flows freely in summer weather. In cool weather it may be advisable to leave the sprinkling of the oil until the warmest part of the day. The oil may be applied at once. If the work is outside and it is desired to delay the sprinkling of the oil, then the surface should be covered with a tarpaulin or something similar to retard the drying out and protect the surface.

Cut-back asphalt oil contains volatile oils that evaporate readily, like gasoline. This oil is used because it will dry on the surface in 18 to 24 hours time so that it can be rammed. This light oil also penetrates rapidly—which is an advantage. The reason for sprinkling the oil on this loose top course is to secure good penetration, and to do it by an easy method.

After the surface is dry, the loose course is packed thoroughly with hand rammers. The same things that were said about rammers used for soil-cement floors also apply for the oil-surfaced floor. If the two sizes of rammers are used the large-faced rammer is used for the first time over. The small-faced rammer should be used for going over the floor two or three times and the large-faced rammer is then used to smooth the surface. The oiled surface upon drying, forms a tough rubber-like cover over the loose material and in ramming the first time over it is better to go over it fairly easy. In this way the cover will not be chopped up so much. A satisfactory floor can be built with a single 6 x 6-inch rammer (See Fig. 2) if the floor is gone over an extra time and rammed a trifle harder.

6. This oil was obtained from the local Service Station of one of the leading companies, and in normal times can be bought from the local stations in barrel lots.

SHOWING STAGES IN PLACING THE TOP COURSES FOR OIL-SURFACED FLOOR.

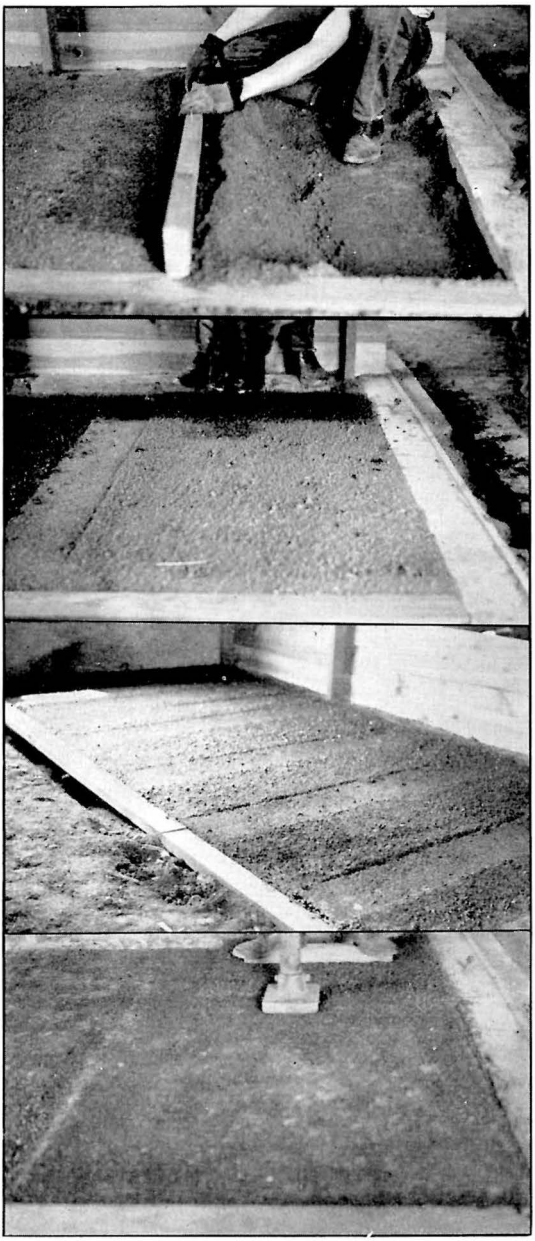

Fig. 11. Striking off the loose soil mixture for the top course with straight-edge, ready for the oil.

Fig. 12. Sprinkling the cut-back asphalt oil onto the loose soil mixture from an old can with perforated bottom. The worker must stand on a plank in doing this.

Fig. 13. The oil has been sprinkled evenly over the surface at the rate of one gallon to 12 square feet and is drying. It should be ready to ram in 18 to 24 hours. Note the marks of the plank made in the soft mixture before the oil was sprinkled. The plank was moved ahead of the sprinkling.

Fig. 14. Ramming the first time over rather lightly with a medium or large rammer. Twice over with a small rammer should follow and then smoothing of the surface with one of the larger rammers. The floor then is finished except for the seal coat of oil from the same barrel.

The Oil and Rate of Applying

The same type of oil is used for all operations in building this floor. This makes it easy to build. Cut-back asphalt—cold mix, is used for the primer coat between the lower and upper course of the floor, for filling the top course, and for the seal-coat on the surface. It will require 48 to 50 gallons of oil to build a floor for a 16 x 32-foot poultry house. One 50-gallon barrel will do it nicely.

Priming Coat. The priming coat is sprinkled on the surface of the lower or base course at the rate of 1 quart to 16 square feet or 6 quarts per 100 square feet of surface and is brushed out before placing of the top course.

Filling Oil. The top course is sprinkled with the oil at the rate of 1 gallon of oil to 12 square feet or 33 quarts per 100 square feet of surface, allowed to penetrate, and left to dry undisturbed. It may be finished just as soon as it will not stick to the rammers. Different rates of applying the filler oil were used in the tests, varying from 1 gallon to 8 square feet, to 1 gallon to 21 square feet. The heaviest application of 1 gallon to 8 square feet was too soft to pack and is not satisfactory. An application of 1 to 16 was used on the 3¼-inch floor listed on Page 3 and this floor is standing in perfect condition. However, a later floor upon which an application of 1 gallon to 12 square feet was used finished nicely by allowing 18 to 24 hours for drying, and it appears that the additional oil makes a slightly higher quality floor. The additional oil will cost less than $1.50 for a 16 x 32-foot farm poultry house.

Seal Coat. A seal coat is a thin coat of light, rapid-curing oil that is spread on the surface of bituminous or "black-top" highway surfaces. The same cut-back asphalt is satisfactory. It should be sprinkled on the surface of these floors and brushed out with one of the modern scrub brushes equipped with a handle as shown in Fig. 15. This brush can be bought at the store for 30 cents. One quart of oil to 20 square feet of surface or 5 quarts to 100 square feet is used for the seal coat. It takes a little time for the seal coat to dry before the floor can be put into service, the time depending upon the weather. If it is necessary to hurry it, a light sifting of fine sand may be used on the surface of the seal coat.

This floor also has some outstanding features that may make it even more popular than the soil-cement floor. Although it is not as resistant to heavy service as the soil-cement, it has easily withstood any service required in the poultry house. It is quite water resistant and it is a better insulating material. It costs less than the asphalt or tar oil-gravel (black-top road type) floors and is definitely easier and more practical to build on the farm. Not only is the same oil used throughout, in building this oil-surfaced floor, but the oil does not require heating. It is used just as it comes from the barrel, and this is a definite advantage.

Use of Other Oils. If the cut-back asphalt oil cannot be obtained and heavier road oils are available, it is possible to use some of them for building this floor. In using heavies oils, it will be necessary to use them in very warm weather or to heat them before using. Road oil heavier than MC-3 probably

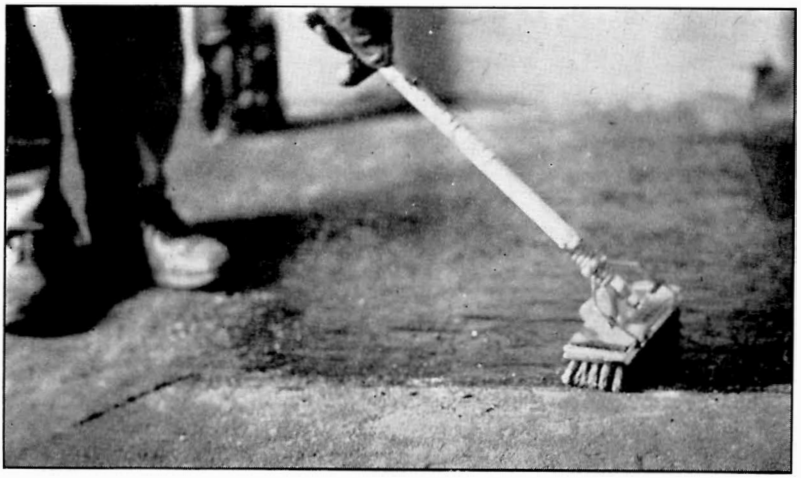

FIG. 15. BRUSHING OUT THE SEAL COAT OF OIL ON THE FINISHED SURFACE.

The seal coat of oil is sprinkled as evenly as possible over the surface at the rate of 5 quarts of oil to 100 square feet. It is then spread with an ordinary 30 cent scrub brush. The priming coat between the base and top course is spread in the same way.

will be hard to handle even in warm weather. Road oils are rated as RC (rapid curing), MC (medium curing) or SC (slow curing). Each oil is then made in several weights; for example, MC-1, MC-2, MC-3, etc. The RC oils dry more quickly, and for this type of construction and for use as a cold oil are the most satisfactory. For the heavier oils more time must be allowed for the oil to dry. MC-3 oil was used satisfactorily in a test floor on a very warm day in this study. Only road oils are suitable for this purpose.

Method of Applying the Oil

Road oil is sticky material to handle and difficult to clean out of containers that may be used in applying. For this reason it is advisable to use containers that may be thrown away after the work is finished. Five-quart salvaged cans that are used for a crank-case fill of oil at service stations were used for spreading oil on these floors. The cans were fixed for sprinkling by driving nail holes in the bottom about three-fourths of an inch apart and at random. A 6d box nail is probably the best size to use for the holes if the work is being done in summer temperatures. In cooler weather slightly larger holes should be used. The oil should flow fast enough to keep the work moving, but the sprinkling should be evenly done on the loose soil and the surface should be well covered after it has had time to spread. In applying the oil the surface must be left smooth and the sprinkling must be done while standing on a loose plank placed across the strip and resting on the form at either edge. (See Fig. 10.) As the sprinkling is done the plank is moved

back, and ahead of the sprinkling. The amount of oil applied does not have to be measured accurately. The amount should be approximately one gallon to 12 square feet of surface and probably should be slightly less, rather than more. No attempt should be made to brush this oil on the surface of the loose layer.

In applying the priming coat between the layers and in applying the seal coat to the finished surface the oil as sprinkled will not completely cover the surface until it has been spread with the scrub brush.

Method of Protecting the Floor

After the loose top course is sprinkled with the filler oil, and while it is left to dry out before it is ready to be given the final packing, the floor must be protected carefully from livestock as well as from rain. During the 24-hour period a rubbery covering is forming over the surface, which must not be broken. If an animal should walk on the surface during this period the tracks will be extremely hard to repair and it is almost impossible to get a good surface where the tracks were made. Care must be used of course by the operator not to step on this surface before ramming. If it has been allowed to dry sufficiently he will be able to stand on it, and follow the rammer as he gives it the first ramming.

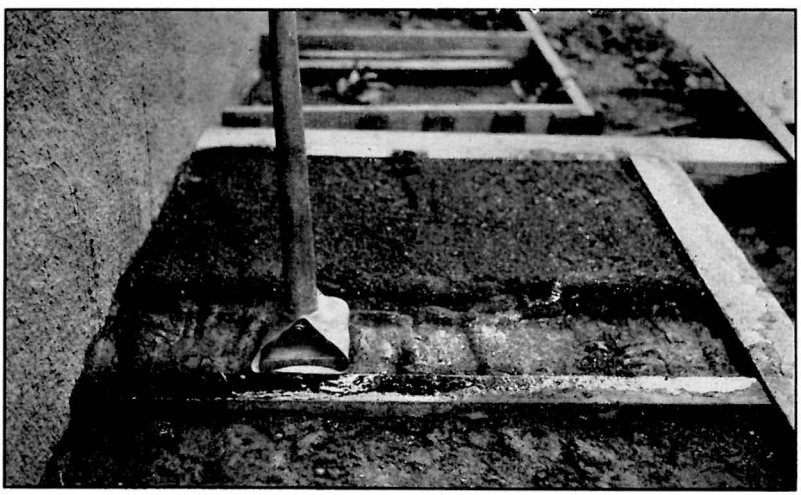

FIG. 16. TOO MUCH OIL WAS USED IN THIS FLOOR.

In this floor one gallon of oil was used for each 8 square feet of floor. This is definitely too much oil. The floor is spongy and will not ram down solidly.

In Building the Oil-Surfaced Floor, This List May Be Tacked Up on the Wall for Reference.

Materials and Equipment Needed

Soil and extra sand—2 yds. per 100 sq. ft.
Oil—10 to 11 gal. per 100 sq. ft.
Mixing floor or space
2 x 4-inch form lumber
Floor rammers—one or two
Spade and shovels
Carpenter's square, saw, etc.
Template boards—two
Sprinkling can for water
Sprinkling can for oil

1. A 3¼-inch thickness is allowed for the floor and space should be allowed for it as the sub-base is leveled off and firmly packed.
2. A light sandy soil is then mixed with enough bank-run gravel, if needed, to make the total sand and gravel equal approximately 75 percent of the soil-mixture. Moisture is added, if needed, as the sand and soil are mixed together.
3. Forms are made of 2 x 4-inch boards staked down on the outside so as to build a continuous strip of floor across the house at one time. The 2 x 4-inch form strips are settled about 3/8-inch to leave exactly a 3¼-inch depth inside, after the sub-base is packed. (See Figs. 3 and 4.)
4. The moist soil mixture is spread evenly between the form boards and "struck-off" level with the top of them by means of a "straight-edge" board. The back of the template board can be used for this.
5. The loose material is then rammed lightly with the large rammer and twice over sharply with a small rammer. This lower course may be left rough on top but it should be level or the finished floor will not be level. The surface, after ramming should be almost exactly 1½ inches below the top edge of the form boards. The template (Fig. 4) should be used for checking the depth and leveling the surface.
6. Two-by-four strips are then laid flat and nailed on top of the form boards to make a total depth of 3¼ inches for the loose top course of the floor. (See Fig. 4.)
7. The can with perforated bottom is then partly filled with oil which is sprinkled on the surface of the lower course of the floor at the rate of about 1 quart to 16 square feet. It is then brushed over with an old scrub brush. This is called the priming coat. In using the oil it will be found convenient to draw-off oil from the barrel into a large bucket or container and dip out of it into the sprinkling can as the oil is applied.
8. The loose top course is put in immediately. The soil-mixture for it is the same as for the base course except that it should contain no coarse pebbles. The loose material is laid down evenly and struck-off as before.

9. The oil may be applied immediately. A plank for the operator to stand on as the oil is sprinkled, is now put in place and the oil is sprinkled evenly over the surface at the approximate rate of 1 gallon of oil to 12 square feet of floor.

10. The doors are closed or barricades carefully set up to prevent even chickens from walking on this oiled surface as it dries. Screened windows should be left open to allow for drying and to carry off the volatile gases that evaporate as the oil dries. All fire or lighted matches should be kept away for the first few hours if the building is tightly closed.

11. When the rubbery oiled surface is dry enough so that it will not stick to the rammer head—18 to 24 hours later—it is tamped rather lightly with the large rammer.

12. It is then gone over twice, ramming sharply with the small rammer and finished to a smooth top surface with the large rammer again.

13. The seal-coat may be applied immediately with oil from the same barrel. It is sprinkled at a rate of about 1 quart of oil to 20 square feet and brushed out with the scrub brush. The floor is then finished and may be used as soon as it is thoroughly dry.

Comments

This experiment station circular is being published at this time because of a demand for the complete instructions for building these two practical floors. A more complete publication, "Farm Building Floors," will be issued after another two years' work has been completed on this project. In the later bulletin more detail will cover the experimental work on these and other floors and methods that were tested and did not prove so practical. The following brief comments will be made at this time:

The reason why the cost of the soil and gravel was not figured in the cost of materials for the various floors is due to the wide variation in the cost of sand and gravel. In some instances satisfactory fine sandy soil could be obtained without adding sand. Clean sand is not necessary to use for the admixture, but if there is too much soil in it, allowance should be made in the soil-sand mixture.

In making the **Oil-Surfaced** floor with 1 gallon of oil to 12 square feet of floor in the top course, the cost of oil would be $1.54 per 100 square feet instead of the $1.26 which was the cost of materials in the floor under test.[7] The rate of oil used in the top course of the two test floors listed on Page 3 was 1 gallon to 16 square feet.

The **Asphalt Oil-Gravel** floor and the **Tar Oil-Gravel** floor were both somewhat brittle and not as smooth as the Oil-Surface floors. They were definitely improved for poultry floors by increasing the oil-rate of highway

7. This cost figure is for cut-back asphalt at 14c per gallon, net.

specifications by 25 percent. If anyone wished to build these "black-top" floors, the instructions in this circular could be used in laying them. The base course of soil-mixture only, would be laid down in the same way as described for these floors.

The **Stabilized Adobe** test floor proved to be smooth and very satisfactory in use. It was more difficult to build and more expensive.

Cinder-Concrete made an excellent floor for the poultry house. This floor is lighter in weight than the conventional concrete floor and just as durable for poultry houses. The cinders should not contain too much of the fine ash and the coarse particles must be hard. Unburned coal and soft pieces should not be used in cinder-concrete. The cinders should be fine enough so that about one-half of them would pass through a one-fourth inch mesh screen. The cement is then mixed with the cinders in the same way as for sand and gravel.

Sawdust-Cement Concrete was found to be difficult to make because it is necessary to have the moisture exactly right. This was difficult to do even with laboratory equipment because of variations in the sawdust. Even though the test floor was made exactly according to specifications and with laboratory equipment, a portion of the floor was too dry and has failed in use. The sawdust for this floor cost $4.00. Not counting the price of the sawdust, this floor cost $7.10 per 100 square feet.

"Raylig," a lignin solution mixed with the top course of a test floor and given a seal coat of cut-back asphalt, has stood up satisfactorily for more than two years. The surface is hard and smooth and the floor is very promising. The process for building it is similar to the others. The raylig was mixed with the soil first and then rammed like the soil-cement floor. At this time raylig is not commercially available except in the west coast region.

REFERENCE MATERIAL

Soil-Cement Roads	Portland Cement Association 33 W. Grand Ave., Chicago, Ill.
Research on the Physical Relations of Soil and Soil-Cement Mixtures	Miles D. Catton Portland Cement Association
Basic Principles of Soil-Cement Mixtures	Frank T. Sheets and Miles D. Catton Portland Cement Association
Stabilizing Road Soils with Raylig	Rayonier Incorporated White Bldg., Seattle, Wash.
The Rational Design of Asphalt Paving Mixtures	Prevost Hubbard, Asphalt Institute 801 Second Ave., New York
Oiled-Gravel Roads of Colorado	E. B. House, Colorado State College Exp. Station, Fort Collins, Colo.
Seal Coats for Bituminous Surfaces	A. R. Legault, Colo. State Exp. Sta.
Stanolind Cut-Back Asphalt	Standard Oil Co., (Ind.) Chicago
The Properties of Salt-Clay Road-Surfacing Mixtures	A. F. Gill, National Research Council of Canada, Ottawa, Canada
Stabilization of Roads with Salt	Canadian Industries Limited, Montreal, Que.