There are three divisions into which I believe bridges may be properly classed. They are:

1. The filled concrete, stone or brick arch.
2. The reinforced concrete flat type types.
3. The all steel truss or girder types as well as the open arch.

In the first division the floor problem is practically eliminated, as it is merely a matter of constructing on the subgrade across the structure a type of road surface which is the same as the rest of the roadway.

Those structures which have been designated as in the second division are likewise not likely to present any serious difficulty, for the reason that no better floor could be devised, in my opinion, than the surface of the slab itself, which needs only to be water-proofed and drained to make an excellent floor.

The structures mentioned in the third division, namely, steel truss, girder, or open arch types, are those in which we find our greatest difficulty not only as regards new construction but maintenance as well.

How often do we see in our travels about the country, especially in those localities which are served mainly by secondary roads, those faulty and dangerous plank floors which have been neglected until they become a serious menace to traffic, sometimes to such an extent that traffic is diverted to other roads, thereby causing great inconvenience and loss to the public.

Each county should have a definite and systematic plan of determining the condition of all bridges at stated intervals. For a period of one or two weeks each year the county commissioners and engineer should examine all bridges in their county and promptly repair or rebuild all those which in their opinion are in need of such repair or renewal. It is false economy to let inadequate or faulty bridge floors exist year after year, because in the long run such neglect results in need for a new structure which will cost far more than proper repairs made at the right time, to say nothing of the inconvenience and discomfort to the general public.

Wabash County Practices

In Wabash County the majority of the bridges are in the third division mentioned above. On nearly all of these bridges
the original floor consisted of lateral floor beams hung from the truss or girders and spaced on the average about 16 feet from center to center. Placed on these beams and running longitudinally were 3\" x 12\" oak stringers and on top of these stringers 3\" planks were spiked to form the wearing surface.

About 20 years ago the replacing of these old plank floors was commenced, and with few exceptions the creosoted wood block floor with a rearranged subfloor structure was adopted. The specifications which were adopted are substantially as follows:

The old floor is entirely removed from the bridge and all steel work thoroughly drawn up until all members have proper tension.

The entire structure is then thoroughly cleaned by the use of wire brushes, after which it is given two or three coats of graphite paint of acceptable quality.

There is then laid in place steel I-beams of proper dimension. These beams run longitudinally and are secured to the floor beams by \( \frac{1}{2} \)\" bolts. These beams are generally spaced 2 feet from center to center. It would seem at first thought that the bolts would become loosened by vibration, but if the bolting is properly done and paint is applied, there is not much chance of any loosening. The two outside longitudinal members are steel channels of the same height as the I-beams.

In order to procure a satisfactory crown in the finished floor surface, steel plates about five inches square and varied in thickness are placed under the I-beams. The thickest of these plates, generally one inch thick, are placed under the center beam and the thickness of each line of plates is diminished toward the outside of the floor. The outside channel rests directly on the floor beams. Steel plates are drilled for the one-half inch bolts which secure the beams to the bridge.

At the center, quarter points, and edge channels, nailing strips of 3\" yellow pine are bolted to the I-beams at intervals of 4 feet. These strips run the length of the bridge and should be tightly drawn up with \( \frac{1}{2} \)\" inch bolts running through the I-beams and strips. These strips provide for spiking down the 3\" plank subfloor.

There is then laid on the I-beams at right angles to the center line of the bridge, 3\" creosoted plank (not less than 6\" in width), which is to be spiked down to nailing strip with 60 D nails. At both ends of the planks there is then bolted in place a 3\" x 6\" felloe guard to hold them in place. This felloe guard is bolted in place by \( \frac{1}{2} \)\" hook bolts which run through the guard and plank and hook under the channel. These bolts are placed 5\' apart and when drawn up tight they hold the plank securely in place. All lumber used is treated
with creosote in the same manner as the floor planks are treated.

On the surface of the creosoted plank there is then laid one layer of two-ply tar paper of good quality. The purpose of this paper is to prevent the hot pitch which is to be poured over the blocks from running down through the planks. A heavy paper of good quality should be used for this purpose. After the paper is laid, it is given a light coat of pitch, which is swabbed on while hot.

Creosoted wood blocks of acceptable design are then laid on the tarred paper in such a manner that joints of about \( \frac{1}{8} \)" are left on all sides of the blocks to permit expansion and contraction. Blocks are laid at an angle of about 22\( \frac{1}{2} \) degrees with the longitudinal center line of the bridge in order that no joint in the blocks may coincide with a joint in the planks beneath. The blocks are not laid flush against the felloe guards, but there is installed between the guards and blocks a suitable expansion joint not less than 1" thick, of the same depth as the blocks and running the full length of the floor. There are a number of good expansion joint fillers on the market and none but the best should be used. The item of expansion and contraction in block floors is an important one and should not be overlooked.

I have found from experience in laying block floors that it is good policy after laying the blocks and before filling the joints to let them lie for not less than 24 hours if possible. They will show a certain amount of shrinkage, especially when laid in warm weather, which will cause the joints to open to the maximum width and permit a better job of sealing. In my opinion block floors should be laid in warm weather to obtain the best results.

At the ends of the floor the blocks may be held in place by steel Z-bars of the same width as the floor. These Z-bars should be bolted to the ends of the I-beams and should lap over the surface of a concrete backwall which is built on the abutment to support the abutting roadway and make a satisfactory connection with the bridge floor.

All joints in the blocks should now be filled with a suitable pitch filler to such an extent that about 10 pounds of filler will be used to each square yard of floor surface. The job of filling joints should be thoroughly accomplished in order that none may be left open and that a tight, water-proof job may be obtained.

Any of the high-grade pitch fillers now on the market may be used. Pitch should be heated to such a temperature that it will pour readily and penetrate into all openings or crevices. It should be of such viscosity that it will not become brittle in cold weather and chip or crack under traffic, or too soft in warm weather and therefore, "bleed."
Following the filling of joints a thin layer of clean sand one-half inch thick should be spread over the surface of the floor for the purpose of taking up all excess pitch. This sand should be allowed to remain on at least two weeks; the excess may then be removed if so desired. The bridge should remain closed to traffic about twenty-four hours after the sand is spread.

Wabash County has had excellent success with the creosoted wood block floor. We have floors of this type which have been in use for more than 18 years. They are still in excellent condition and the maintenance cost per square yard has been negligible.

I realize, of course, that the foregoing specification is for a structure which requires new steel throughout and a general subfloor renewal. All bridges of this type, however, do not require all new steel, and this, of course, cheapens the work to some extent.

In the study of any bridge, prior to making specifications for floors, the engineer should, by ingenious methods, utilize all old material possible in order to keep costs to a minimum.

**An Example**

It is not always necessary, of course, to adhere strictly to a standard specification for a type of floor. About four years ago in Wabash County, there was just outside one of our small towns on a highway a bridge which had quite heavy traffic and which was just about ready to fall into the stream. As we were short of money in the bridge fund, I decided, in order to keep within the limit of our money, to make an experimental job of repair and at the same time put the structure in condition to accommodate the traffic.

The old bridge was composed of two outside steel arches tied together with two 12" cross beams which supported the floor. The whole structure was supported by vertical steel I-beams, backed with slabs of stone to hold back the road embankment. The clear roadway on the old structure was 14 feet and it was decided that it should be increased to 18 feet. This was accomplished by inserting three 15" I-beams running longitudinally and securing them to the floor beams, then on top of these 15" beams were placed 5" I-beams each spaced 2'-6" from center to center. Each of these I-beams was 19 feet long and of course extended out over the trusses; but as they were all securely bolted to the longitudinal beams on which they rested, this small extension was not considered dangerous.

After the 5" beams were in place, corrugated metal arches curved to proper radius were inserted in each bay and the whole floor was then filled with concrete to a point three inches above the beams. This concrete floor was then rein-
forced by 6" x 6" No. 6 steel wire mesh. On each side of the floor 6" curbs were turned up to a point 6" above the floor and a 2 1/2" galvanized iron guard rail was inserted in each curb.

After this floor had properly set, it was then thoroughly waterproofed by swabbing on three coats of hot pitch, on the final coat of which there was spread a layer of sand.

The contract price for this bridge was $2,371.00, of which the greater portion was for concrete abutments and wing walls. Since the contractor's proposal was a lump sum, the exact cost of the floor, including all new steel work, could not be determined; but according to what calculation I have made, the price of the floor did not exceed $6.50 per square yard.

A recent examination of the structure which has been in use for four years reveals that it is in excellent condition and will give many years of service to the public.

This old bridge, which was practically worthless, was rebuilt into a useful structure for the sum of $2,371.00; this amount represented a saving of approximately $2,500.00 for the county, as a former estimate for a new bridge was $4,800.00.

**Creosoted Timber Slab**

Another type of floor material which has been used to some extent in Wabash County in the last three years is a creosoted slab made up of six pieces of 2" x 4" oak lumber. The 2 x 4s are fastened together by means of bolts which run through holes in the six pieces of oak drilled for the purpose. These bolts hold the 2 x 4s together, forming a compact unit 12" in width by 4" thick. Each of these units when laid in place is fastened to the adjoining ones by steel pins which hold the floor in place.

The subfloor structure is first placed in proper condition, and on top of the steel or wood stringers are laid 2" x 6" pine nailers. These nailers are not secured to the I-beams but the slabs are spiked to them, strengthening and holding the slabs in place. After they are in place, a 3" x 6" creosoted plank is spiked to each outside edge of the floor, holding the slabs in line and further securing them. The slabs are of first class oak impregnated to refusal with creosote.

These floors have been laid only by the county road maintenance department, no contracts having been awarded. The material makes a first class floor and is readily handled and laid in place, no skilled labor being required. The cost per square yard for this type of floor, including the subfloor, is approximately $10.50.

Another type of floor which has proved to be a success in our county and which is used on bridges under 36' span is made up of small concrete arches supported by steel I-beams.
spaced about 2'-4" from center to center and supported by abutments. Forms for these arches are made of corrugated galvanized iron of about 20 gauge curved to the proper radius. These forms are inserted between the beams and are held in place by the lower flanges of beams. Concrete is then poured in each space between the beams to a point about two or three inches above the top flanges. The surface of the floor is then water-proofed, sanded, and made ready for traffic.

The steel beams in the floor are secured against spreading by the placing of 1" bars which are spaced about 6 feet apart and run across beams both on top and bottom flanges and are hooked on their ends. Several of these floors were constructed a few years ago over large dredge ditches with the idea in mind that if necessary the floor could be easily removed in order that dredges could pass through, after which the steel could be replaced on the abutments and the floor rebuilt.

In conclusion I wish to emphasize again the fact that it is poor policy to neglect bridge floors or any other part of a bridge for that matter, as we see them neglected by the hundreds over the state. A bridge is not different from other structures or buildings which are subjected to the damaging actions of the elements and to other destructive factors which are constantly attacking them. To erect such structures and then disregard them until they fall to pieces is, to my notion, a mighty poor way for public officials to serve the taxpayers.

CONSTRUCTING A SEWAGE TREATMENT PLANT

By W. P. Cottingham,
City Engineer, Gary, Indiana

All Indiana cities are going to be interested in the construction of sewage disposal plants—either for themselves or for their neighbors. If your city has no need of a sewage disposal plant, it is more than likely that you are vitally interested in having your nearest neighbor city construct a sewage disposal plant because, without it, it is contaminating your water supply. In our corner of the state we are certain that if our neighboring cities of Hammond, East Chicago, Whiting, and Chicago would stop emptying their waste into Lake Michigan we wouldn’t have to keep spring water for drinking purposes at certain seasons of the year. And I suppose each of those municipalities are equally certain that the entire contamination is traceable to the other cities.

It has required an order from the State Health Board of