# Some Preliminary Notes on the Hygienic Value of Various Street Pavements as Determined by Bacteriological Analyses.

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In many of our large cities, and small ones, too, the question of pavement is a very important one. The government looks largely upon the question of economy, the life of the particular pavement being perhaps the most important factor in assisting them to a decision for or against it. Some pavement companies in pushing their own work, will claim that their pavement is more sanitary than this or that one. Have they any data, any facts that will permit them to make such statements? It was partly for the purpose of settling this question that the foregoing experiments were undertaken.

In working on this subject, it has been found that the sanitary or hygienic value of a pavement depends almost entirely on its power to collect, retain or give up dust, although there are other factors, such as reflection of heat, etc., that must be considered. But this dust leads to a discussion of the point as to whether a strictly sanitary pavement is one that will remain moist the longest time, thus holding on to the dust, and at the same time, perhaps, permitting the multiplication of bacteria; or whether the sanitary pavement is the one that dries the quickest, and with the assistance of traffic and the winds, scatters the dried dust broadcast.

Street dust is always laden with bacteria, and it was thought that possibly some bacteriological analyses under different conditions might assist in the solution of this problem. It is not necessary to state that aside from the bacterial contents of dust, hygienically speaking, it in itself is an irritating factor to the mucous membrane of the nose and throat, as well as to the delicate membranes of the eye. And thus, without taking the bacteria into account at all, the pavement permitting the least dust would be regarded as most sanitary. But the bacteria usually occur in proportion to the amount of other dust, so the measure for one will serve fairly well as an indicator for the amount of inorganic dust. The experiments herein reported were undertaken on the Lafayette, Indiana, pavements, including macadam, brick, wood block (not creosoted), and sheet asphalt.

There is almost no reliable literature on the subject, and what little there is seems to universally condemn the uncreosoted wood block pavement.

From Byrnes Highway Construction, 1893, Dr. O. W. Wight, Health Officer of Detroit, in a report to city council, says: "On sanitary grounds, therefore, I must earnestly protest against the use of wooden block pavements. Such blocks, laid endwise, not only absorb water which dissolves out the albuminous matter that acts as a putrefaction leaven, but also absorbs an infusion of horse manure, and a great quantity of horse urine dropped in the streets. The lower ends, resting on boards, clay or sand, soon become covered with an abundant fungoid growth, thoroughly saturated with albuminous extract and the excreta of animals in a liquid putrescible form. These wooden pavements undergo a decomposition in the warm season and add to the unwholesomeness of the city. The street in fact might as well be covered a foot deep with rotting barnyard manure so far as unwholesomeness is concerned. Moreover, the interstices between the blocks and the perforations of decay allow the foul liquids of the surface to flow through, supersaturating the earth beneath and constantly adding to the putrefying mass."

M. Foussagrivs, professor of hygiene, at Montpelier, France, objects to wooden pavements because they "consist of a porous substance capable of absorbing organic matter, and by its own decomposition giving rise to noxious miasma which, proceeding from so large a surface, can not be regarded as insignificant. I am convinced that a city with a damp climate, paved entirely with wood, would become a city of marsh fever."

An article by Amat in the Bull. Gen. de Therapeut, is of some interest in this connection. He compares the advantages and disadvantages of wood pavement with those of granite blocks and asphalt. In regard to cleanliness he places then in the order of merit—asphalt, granite, wood. In regard to quiet—wood asphalt, granite. In regard to cheapness—granite, wood, asphalt. Durability—granite, asphalt, wood. Ease of repair—asphalt, wood, granite, and safety—wood, asphalt, granite.

Miguel tested bacteriologically some ten-year-old wood pavements, and found from a million to a million and a half germs in a gram of sawdust from the surface, and from five hundred to four thousand in a gram of the sawdust taken two inches below the surface. These same experiments were repeated by Rolst and Nicoles, giving the same relative results, but the numbers of bacteria being twenty times as large.

Professor Brown, of Yale College, says that "even in the free air and full sunlight, along with the putrescence, a white fungous growth begins on the surface of the wood, which rapidly becomes slimy. This forms much more rapidly on the ends of the grain of the wood than on the radial or tangential sides. The fungous growth goes on, modified of course by the temperature and the degrees of concentration and it continues for an unknown period, or until decay has become complete. Heartwood and sapwood act alike in this matter; the difference is one of degree rather than character."

The Legislature of New South Wales (Australia) appointed a board to "inquire into the alleged deleterious effects of wood pavements upon the public health. The board examined specimens of wood pavements as laid in the city of Sidney, taking up blocks at different points. In all cases the concrete bed underneath was moist; in three cases a large amount of slimy mud was found, giving off an ammoniacal odor. The blocks were chemically examined to determine whether they had absorbed organic matter, with the result that some were found impregnated with filth to the very center, while others were comparatively free from it. The board comes to the conclusion that wood is a material which can not safely be used for paving unless it can be rendered absolutely impermeable to moisture. * * * So far as the careful researches of the board go, the porous, absorbent and destructible nature of wood must, in its opinion, be declared to be irremediable by any process at present known; nor were any such processes discovered, would it be effectual unless it were supplemented by another which should prevent fraying of the fibers. Still less can the defects of wood be considered of less consequence than the defects of other kinds of materials. * * * Your board therefore recommends that the paving of the streets of this city with wood should be discontinued, and desires to add that this recommendation is extended to apply not to the particular mode of construction here adopted alone, but to the material itself and to every known method of construction."

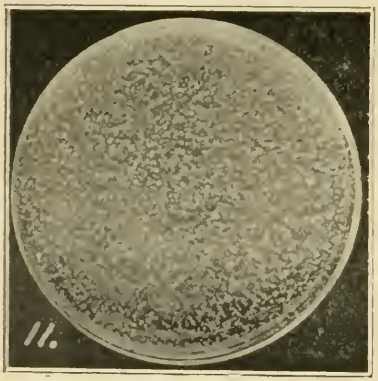
On the other hand, a comparison of the death rate in cities using wood pavements with that in cities where little or no wood is employed seems to show that wood pavements do not cause an increase in the death rate, i. e.:


Macadam.

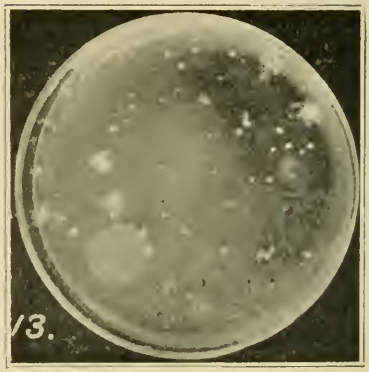

Sheet Asphalt.


Wood Block.


Brick.




Sheet Asphalt.




Brick.

| *City.* | *Death-rate.* | *Percentage of Wooden Pavements.* |
|---|---|---|
| New York | 25.19 | 0 |
| Boston | 23.06 | 0 |
| Philadelphia | 19.74 | 0 |
| Nashville | 23.70 | 0 |
| Atlanta | 19.87 | 0 |
| Milwaukee | 16.90 | 48 |
| Chicago | 17.48 | 80 |
| Detroit | 14.70 | 91 |
| Duluth | 99.17 | 95 |

If there were not so many other conditions this might be convincing in favor of wood block. All these data were collected about 1890.

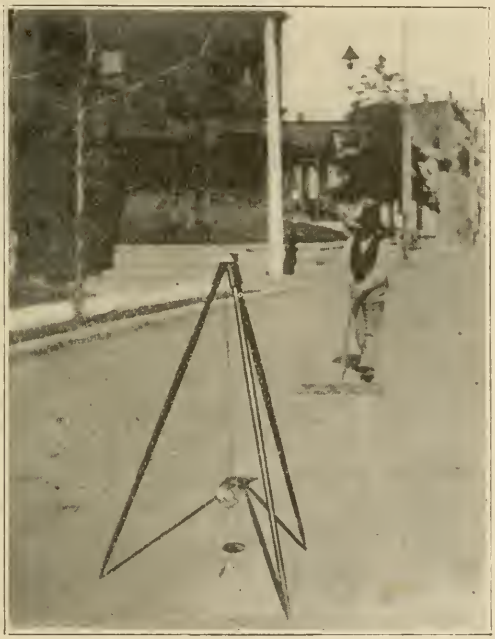


Fig. 1.

The two latest books on pavements (1893 and 1894) contain nothing better. As far as technical journals are concerned, the matter seems to be considered satisfactorily settled by such arguments as the preceding; no further investigations along these lines seem to have been made.

METHODS OF ANALYZING AIR OF PAVEMENTS FOR BACTERIA.

The bacteriological examinations were carried on by means of using the agar plate exposure, four-inch Pasteur dishes being used. These agar plates were exposed (always in duplicates) on an ordinary surveyor's tripod, as shown in Fig. 1. This made the exposure about five feet above the pavement. Half way between the exposed plates and the pavement hung the anemometer, which had to be used to determine differences in wind velocities from minute to minute. These plates were always exposed for exactly ten minutes, and careful notice taken of the amount of traffic, direction of wind, and anything that would affect the amount of floating dust. Great care was taken to see that the wind was blowing as nearly parallel to the street as possible, so that the analysis would surely be of the street dust, and not of the dust from the adjoining lots.

One set of exposures was made between 12 and 2 o'clock at night when the life on the streets would be at a minimum. The results of this set of plates were as follows, the numbers indicating the number of bacterial colonies on each agar plate that had had an exposure of ten minutes:

| | |
|---|---|
| Wood block (uncreosoted), Plate No. 3 | 50 |
| Brick, Plate No. 5 | 16 |
| Sheet asphalt, Plate No. 2 | 14½ |
| Macadam, Plate No. 1 | 9½ |

The numbers indicate the average number of bacterial colonies on the two plates that were exposed side by side over each pavement.

Another interesting set of exposures was made at a time when the macadam street was muddy, the brick pavement was fairly dry, except for moisture in the interstices, and the sheet asphalt was dry. A drizzling rain had occurred about twenty-four hours previous to the exposure. Results as follows:

| | |
|---|---|
| Sheet asphalt, Plate No. 11 | 2850 |
| Macadam | 147 |
| Brick, Plate No. 13 | 99 |

In this exposure it was evident that the sheet asphalt pavement had become quite dry and the dust was stirred up to a very considerable de-

gree by the passing traffic, fifty-three carriages, two bicycles and one horseback going by during the ten minutes' exposure. The wind was very light.

Another exposure was made when everything was dry, and after the wind had been strong and gusty for some hours, with the following results:

| | |
|---|---|
| Macadam | 958 |
| Brick | 463 |
| Wood block (uncreosoted) | 304 |
| Sheet asphalt | 180 |

Here the sheet asphalt had apparently been wind-swept, and was clean and dry.

The averages of all exposures, excluding the midnight one, were as follows:

| | |
|---|---|
| Macadam | 1386 |
| Sheet asphalt | 1084 |
| Brick | 960 |
| Wood (uncreosoted) | 361 |

Therefore, if the amount of dust floating over any given pavement is a measure of the sanitary value, these pavements in question will take the following rank: wood, brick, sheet asphalt and macadam. The above averages include exposures under all kinds of varying conditions.

While we do not feel that we can conclude anything very definite from these experiments, they seem to point to possible conclusions of value if pursued to the proper extent. Previous opinions commending or condemning any pavement from the sanitary standpoint lack scientific foundation, and therefore are not to be seriously considered. In the experiments herein reported there are a number of factors that need to be more carefully determined, such as, that the bacteria that are caught on the agar plates actually come from the pavement and not from the surrounding lots and buildings; and furthermore, that these bacteria are of a pathogenic nature or not. These uncertain features are receiving careful attention in our future experiments, and it is hoped that in their study will be found the key to the solution of these pavement problems.