

Mr. Gray: I made some myself on a very level piece of road, and in place of putting them in the centre path on the bottom of each side ditch, I put them down one and a half feet, and they worked very well. We have had them in for four years.

Mr. MacDonald: Our trolley system runs parallel with our roads, and in the spring of the year, when the earth is surcharged with water, it has forced water up through the pavement and made no end of trouble. We have intercepted that with a system of drainage such as you suggest. We have put in the gravel to keep it from clogging up and covered that with hay.

Mr. Howland suggested that the cesspool method would obviate the blind drain.

Mr. MacDonald: We have long stretches of road where we cannot get any drainage without making a pocket and providing an artificial drain. Ultimately, the thing will have to be taken care of, and they are beginning to learn in our eastern states that a one per cent. grade is the minimum on a dirt gutter. It was not up to us when we had so little travel. We never thought of automobiles in the early days, and so we are learning everything connected with these things, and now that we are getting fifteen-ton trucks they have got to be cared for.

### Roads and Bridges Too Weak

I calculate that out of the 200,000 miles of roads built in the United States up to a few years ago, we have not one-quarter of them, and not ten per cent. of the bridges over our streams and rivers that would carry the traffic safely over them to-day. But we have got to take that up and we have got to commence all over again. That is why we are here to tell you of the things we neglected to do, so that you may gain the full benefit of that experience we have gone through.

Mr. Drinkwater: With regard to the traverse French drain across the travelled area of a road, do you think it is advisable to build that drain deeper than the full depth of the side ditches? That is to say, if the ditches are two feet below the finished grade of the road, is it advisable or a judicious expenditure to make those cross ditches blind drains three and a half feet deep?

Mr. MacDonald: I don't think so, because it would be an engineering problem in which it would suggest that water will not run up hill, and that your side ditches are made for a particular purpose, to draw your water out of the road and away and not into your blind drain.

Mr. Wray: With the ordinary joint is there not a tendency to block and cause difficulty in keeping the drain clear?

Mr. MacDonald: We have never had any trouble. We sometimes cover with muslin or have some little covering at the joint. The main thing we want is to ensure by a spike or something put in on the side of the road that will keep the alignment of pipes, that joints will not dodge.

Before installing our glazed tile in the culvert we fit all pipes on the bank. I am referring to the regular D drain that butts up flush. We lay them on the board, we put down our guides so as to get the exact level straight through, and we put down our members so as to cover that, and we put the tile on that board straight through and measure to see they are accurate, with a spike on the side to hold them in place and keep flush and butt up close, and we cover that over with a little muslin, and put over that fifteen to eighteen inches of gravel or crushed stone and cover that with hay.

The great trouble, if they are carelessly done, is that the sand percolates through and works the joints out, and the last condition is worse than the first. Your tile drain should do two things: seep out the surrounding ground and carry it through.

Mr. Gray: Do you think it absolutely necessary to put a board under a tile drain pipe?

### Laying Tile Drains

Mr. MacDonald: I would prefer that to laying it down even on a clay bed, because the ooze that will come through will soften the bed under your joints and they will get loose with nothing to hold them. The board itself will make a protection for your pipe remaining in its alignment. I presume you could get along without it, but it would be at the risk of some trouble with your pipe later on.

Mr. Gray: Having had considerable experience in laying tile, I have never yet put on a board. My reason would be that, although the condition of the soil under that tile may change somewhat, oozing could not well take place if the tile was properly laid. If your lumber is not uniform all the way through and some spots decay before others, then your tile drops and away your drain goes. I have had occasion to take up a good deal of tile, and last year we took out some drains that had been in twenty-four years and they were just as clean and level as the day they were put in.

Mr. MacDonald: That might be. I have known tiles been down for many years, and I have taken up spruce and hemlock thirty to forty years in the ground in a good state of preservation. The wood itself would guarantee that there was no buckling there—it could not buckle very well; whereas in my experience I have known tile all awry and gone to pieces, and there was nothing to prevent it. The wood helped to make the protection. However, if you have had that experience, continue it so long as it makes you a return for the money invested.

### No Planks Under Culverts

Mr. Fraser: Would you recommend putting planks under a pipe culvert?

Mr. MacDonald: No; we don't put them under a pipe culvert.

Mr. Fraser: Or concrete culvert?

Mr. MacDonald: No; we have cemented up the joint and put them in that way. There is a sufficient surface to make a sustainment all through. See that they are level bedded, so that the bell goes down and furnishes its own bridging, so that there is no possibility of snapping or breaking. I have not laid much cement tile. I was afraid to put them down where the ends were open for fear of the frost making trouble, but if I were I would not put plank under them.

Mr. Drinkwater: Is it detrimental to a tile to be porous? Some say that the field tile, being non-porous, is better than the cement tile, which might be porous.

Mr. MacDonald: It depends altogether if you want a vehicle to carry water through or a vehicle to absorb water into. If you want a light tile drain for land drainage it would be a great deal better to have a porous tile. If you wanted to have it to carry through the culvert into the sewer I would suggest you have a double thick salt glazed tile. My idea of a tile is that the seepage comes in at the end. The objection often raised is that the cement tile, being porous, is not a fit tile to be put into a drainage system, while a clay tile, being non-porous, is.