cement, as follows: When the tip consists simply of slag blocks from blast furnaces, the space left between the blocks being pretty large, the work would require the injection of a vast amount of cement, and the operation could not be conducted easily over a certain height. In most cases, however, the tip is formed of debris of all kinds, especially clay and earth, and in this the injection of cement is attended with bad results. The Franki pile gives full security, because it not only passes through the tip, but also through the bad soil which lies underneath it, and rests on a strong foundation of clay or gravel.

Mr. Lamberton asked further whether it would be possible to drive tubes having a diameter of 1 yard into a tip of 10 yards in height; in the affirmative, what was the time required for the operation and the cost of the pile. We have driven 180 Franki piles, at the Société d'Ougrée-Marihaye, into a tip composed entirely of slag blocks to a height of 30 ft. resting on 15 ft. of bad soil. The work, therefore, was more difficult than the one alluded to by Mr. Lamberton, and, nevertheless, we regularly made one pile a day with each pile-driver. That the first tube at the ground level had a diameter of 1 yard and a height of 1½ yards was due to the necessity of first digging a hole of such dimensions as to enable the use of tube lengths suitable for the required depth. The upper tube had a diameter of 24 in., the mean one a diameter of 20 in., and the lower one a diameter of 16 in. In a strong ground, free from water, it is not necessary to work with tubes of great diameter, the concrete spreading easily against the walls of the cavity, and agglomerating round the stony materials forming the pile, and increasing the diameter of the latter.

As to the price of the Franki piles, it is generally of $5.00 per yard, for piles driven into an easy, soft, or marshy soil. But in tips of slag blocks, where piling is slow and difficult, the price rises up to $10.00 per yard. From the economical point of view, the following may be regarded as a typical instance:—

One thousand Franki piles are now being driven on account of the Vilorde Coke-Ovens Company. Each pile contains 123.5 cu. ft. of concrete. The total volume of the concrete thus poured in a relatively small area is about 45,800 cu. yds. If reinforced concrete piles made in advance had been used, the cost of the foundations would have been three times as high as that paid by the Vilvorde Coke-Ovens Company to the Frankignoul Company, supposing that, in order to obtain the same compression of the soil, an equal volume of concrete had been driven in the shape of such ready-made piles.

ELECTRICAL POWER IN CHICAGO.

Chicago leads the world in the production of electric power. The output of 303 electric-supply undertakings in Great Britain for the year 1911-12 amounted to 1,127,499,742 units, but Chicago by itself has an annual output of over 800,000,000, and expects within a year to turn out a billion. The Chicago Commonwealth Edison Co., generates more current than the local Edison companies of New York, Philadelphia, Brooklyn and Boston combined. The Eastern companies, however, do not supply power for local transportation, while the Chicago company does. The latter operates the largest single electric-power-generating plant in the world and its price for its product is said to be lower than that of any other electric power-vending company in the world.

TREATMENT OF WORN OUT AND RAVELLED MACADAM SURFACES.*

By Col. Edmund A. Stevens,
State Highway Commissioner of New Jersey.

BEFORE discussing the cure it is well to define the trouble, and to analyze its causes. The word Ravelling is used rather loosely. For my purpose I shall consider it as the loosening of the bond of a road surface until the macadam stone lies loose and free on the road. By macadam stone, I mean, not the small stone used to fill voids and give a smooth finish to the surface, but the stone that constitutes the body of the road's surface. In macadam work this stone when compressed to its final form occupies about 60 per cent. of the volume of the road surface. The 40 per cent. of voids is filled in varying proportions with surface stone, screenings, stone dust, sand, earthy materials and any chemical binder used to "hold the road." The mixture of fine stone, sand and earth filling the voids has no appreciable tensile strength. Its duty is to wedge the macadam stone in place and prevent internal movement. Such a structure is called on to carry loads, to receive and absorb propelling thrusts. The road should be of sufficient depth to transfer the stresses thus imposed to the sub-base without serious internal movement and at unit pressures less than the resisting power of the soil. It is thus subjected to vertical and horizontal forces that contribute largely to ravelling.

Let us briefly consider these.

A draft horse weighing 1,200 lbs. will have all his weight at one time on two feet. He will exert, say, one horse-power at a speed of 4 miles. The vertical force at the foot is 600 lbs., the horizontal $\frac{23{,}000}{2 \times 4 \times 88} = 47$ lbs. These forces are or may well be concentrated on a toe calk two inches in width; the resultant force slightly exceeding 300 lbs. per linear inch.

A motor truck, loaded, 16,000 lbs. and exerting at the wheel rims, say, 30 horse-power at 10 miles an hour, will, with 60 per cent. of load on rear axle, exert a vertical force of 4,800 lbs. and a horizontal of 562.5 lbs. at each rear rim, the resultant being about 800 lbs. per lineal inch for six-inch tire.

For a pleasure car weighing 4,000 lbs. with 60 per cent. of weight on rear axle and exerting 40 horse-power at the wheel rims with a speed of 35 miles, the vertical force at each wheel is 1,200 and the horizontal 214. The resultant is about 400 per linear inch for a bearing width of 3 inches.

At curves with high-speed cars, the horizontal force is considerably increased, for it is impossible to so "bank" a curve as to suit the speed of all classes of traffic.

In the case of wheels transmitting vertical loads only, observation indicates but little dust raising from a road not overlaid with loose dust. Such a wheel will at the point of mathematical tangency have no velocity relative to the road; a vertical velocity is imparted to it, and as any section leaves the surface it will raise with it any of the lighter particles that are loose and may come into contact with it. At the driving wheel there is a slight slip which in addition to lifting will throw particles backwards.

* Read at American Road Congress, held at Detroit, Mich., September 29th to October 4th, 1913.