by the Author's father, the late Mr. W. R. Morris, M. Inst., C.E.

The Author then described the New Cross Reservoir, built under his direction in 1874, which was similar to that on Woolwich Common, except that the roof consisted of brick arches springing from the piers instead of rolled joists. He then gave a full description of a reservoir recently constructed by him at Farnborough, Kent, in which the outer walls were reduced to a minimum, by supporting the covering arches till their springing was level with the centre from which they were struck. This system was adopted for the end as well as for the side walls. An account was given of a slip which occurred during the construction of the reservoir, and of the means taken for making the work secure.

The East London Waterworks Company had at Hornsey Wood a fine brick reservoir which was capable of containing 5,000,000 gallons of water. The same Company had at Haggar Lane a reservoir capable of containing 1,500,000 gallons. This also was built of brick, the vaulting was supported by longitudinal walls, stiffened by transverse walls, so that the reservoir was divided into forty-nine sections, the walls of which were pierced with circular openings. The Kilburn Reservoir, capable of containing 6,000,000 gallons, was a fine brick structure, with vaulted roof, supported on cruciform piers, the outer walls were supported by buttresses against the pressure of the external earth. The Hampton Reservoir, capable of containing 2,750,000 gallons, was constructed entirely of concrete. This reservoir was built in clean sharp gravel, and the excavated ballast was admirably adapted for the concrete. The arches sprung from wrought-iron joists. The Barton-on-Trent Reservoir, built for the South Staffordshire Waterworks, had a capacity of 4,000,000 gallons; it was rectangular on plan, and was covered with brick arches springing from cast-iron girders, supported on cast iron columns; the walls were of concrete, faced with Staffordshire bricks.

The Author then referred to several service-reservoirs, of which he had the opportunity of learning some particulars during a recent tour. The Charlottenburg Reservoir of the Berlin Waterworks, with a capacity of 5,000,000 gallons, was built of brick, with walls sufficiently thick to resist the internal pressure of the water; the soil was fine loose sand, on which bitumenised paper was spread before laying down the concrete foundations. The Berlin filter-beds were covered with Bohemian vaulting, the foundation of which rested on gravel puddle. The reservoir at Breslau, capable of containing 900,000 gallons, was supported on a tower 150 feet high, and the tower contained the pumping-engines. The Author then described one of the Vienna reservoirs, and furnished some notes on the aqueduct which supplied that city. The waterworks of the city of Munich, which were in course of construction at the time of his visit, comprised a reservoir having a capacity of 8,800,000 gallons, the walls and floor were of concrete, the vaulting was semicircular, built with one ring of brick. The Author gave a sketch of the Frankfort Reservoir and some notes as to the water supply of the city. The reservoir and works of the Darmstadt Waterworks were noticed; the reservoir was of brick, built above ground, it was capable of containing 900,000 gallons; the water was pumped from six tube-wells, sunk in the sandy plain between the Odenwald mountains and the Rhine at Griesheim, about 5 miles from the city. The reservoir at Cologne, which consisted of a cast-iron tank, with a capacity of 800,000 gallons, was erected on a tower 100 feet high; the water supplied to the city was pumped from wells on the banks of the Rhine; but the spring-water was quite distinct from the Rhine water. The Dresden Reservoir was capable of holding 4,600,000 gallons of water. The Hanover Reservoir, with a capacity of 2,400,000 gallons, was of brick. It stood 30 feet above the ground-line, and the outside walls supported the full pressure of the water without the assistance of any embankment.

After some remarks on the marked preference of Germans for spring-water as compared with lake-water or river-water, the Author concluded the Paper with a sketch of his idea of a model service-reservoir. This was so arranged that the earth dug from the excavation was all utilised in forming the necessary embankment. The floor and the side-walls were of concrete, the piers, arches, and vaulting of brick. The vaulting was similar to that of the Farnborough Reservoir; but the ends of the vault were brought down with a curve of 12 feet 6 inches radius till they rested on correspondingly curved bays in the concrete and-walls. By this construction the thrust of the roof would be carried down to an abutment reaching against undisturbed ground, and the pressure of the water on the reservoir would not only be supported by the abutment, but be also counterbalanced by the weight of made-earth facing the embankment, which rested on the exterior arches of the reservoir, in addition to the pressure of the earth which would have to resist internal pressure if the walls were vertical. The Author held that the whole of the interior surface should be rendered in cement mortar.

REPORT OF COMMISSION ON WIND PRESSURE ON RAILWAY STRUCTURES.

MEMBERS.—SIR JOHN HAWKSHAW, SIR W. G. ARMSTRONG, W. H. BARLOW, PROFESSOR GEORGE G. STOKES, COL. WM. HOLLAND.

The conclusions arrived at by the Commission were as follows:—

1.—That for railway bridges and viaducts a maximum wind pressure of 56-lbs. per square foot should be assumed for the purpose of calculation.

2.—That where the bridge or viaduct is formed of close girders, and the tops of such girders are as high as or higher than the top of the train passing over the bridge, the total wind pressure upon such bridge or viaduct should be ascertained by applying the full pressure of 56-lbs. per square foot to the entire vertical surface of one main girder only. But if the top of a train passing over the bridge is higher than the tops of the main girders, the total wind pressure upon such bridge or viaduct should be ascertained by applying the full pressure of 56-lbs. per square foot to the entire vertical surface from the bottom of the main girders to the top of the train passing over the bridge.

3.—That where the bridge or viaduct is of the lattice form or of open construction, the wind pressure upon the outer or windward girder should be ascertained by applying the full pressure of 56-lbs. per square foot, as if the girder were a close girder, from the level of the rails to the top of a train passing over such bridge or viaduct, and by applying in addition the full pressure of 56-lbs. per square foot to the ascertained vertical area of the surface of the ironwork of the same girder situated below the level of the rails or above the top of a train passing over such bridge or viaduct. The wind pressure upon the inner or leeward girder or girders should be ascertained by applying a pressure per square foot to the ascertained vertical area of surface of the ironwork of one girder only, situated below the level of the rails or above the top of a train passing over the said bridge or viaduct, according to the following scale, viz:—

a. If the surface area of the open space does not exceed two thirds of the whole area included within the outline of the girder, the pressure should be taken at 28-lbs. per square foot.

b. If the surface area of the open spaces lie between two-thirds and three-fourths of the whole area included within the outline of the girder, the pressure should be taken at 42 lbs. per square foot.

c. If the surface area of the open spaces be greater than three-fourths of the whole area included within the outline of the girder, the pressure should be taken at the full pressure of 56-lbs. per square foot.

4.—That the pressure upon arches, and the piers of bridges and viaducts should be ascertained as nearly as possible in conformity with the rules above stated.

5.—That in order to ensure a proper margin of safety for bridges and viaducts in respect of the strain caused by wind pressure, they should be made of sufficient strength to withstand a strain of four times the amount due to the pressure calculated by the foregoing rules. And that, for cases where the tendency of the wind to overturn structures is counteracted by gravity alone, a factor of safety of 2 will be sufficient.

Where trains run between girders they will generally be sufficiently protected from the wind, the degree of protection afforded by the girders depending upon the extent to which the girders are open or close; where the girders are so open as to afford insufficient protection, or where trains run, as in some cases they may do, on the tops of girders, we assume that the engineer will provide a sufficient parapet, but we are indisposed to go further into detail on this subject, as it might tend to stereotype modes of construction which we think is undesirable.

In conclusion we beg to point out that the velocity of wind, like that of every other moving body, is more or less retarded