been, or rather what its weight or specific gravity? As well as static and kinetic friction (that of repose and motion), there are sliding and rolling friction, the latter of which might obtain if the undestroyed, undiluted portions of the cementing materials were hard, silicious sand or small pebbles, and acting as so much grape or canister shot. Now to take an extreme case, as merely illustrative of the danger—facility with which a wall might be moved forward if resting on a bed or stratum of shot between steel plates, the coefficient of friction would or might be only from the $\frac{3}{8}$ to the $1\frac{3}{8}$ of one per cent. of the weight to be moved, say 1 per cent. in round numbers, when a wall of specific gravity 2 would have to be 50 times the weight or pressure of the water, or in thickness 50 times the height of the impounded water.

But this coefficient of only one per cent. of friction could only obtain with large sized incompressible spheres of steel rolling in parallel channels of an unyielding thickness of like material; and these conditions could not obtain with the smaller, unspherical and not incompressible sand pebbles between the rough surfaces of the under and overlying beds of masonry.

The coefficient of rolling friction would in such case be increased to at least 10 per cent. instead of one hundredth; when with a like specific gravity of 2.0, a dam wall would have to be in thickness only five times the height of water or other fluid material to be retained.

Now, not even is this coefficient of rolling likely to obtain, though it may be more or less approximated to, in certain or extreme cases. But, on the other hand, the coefficient of sliding motion may certainly be less than .5, and when the lubricating effect of water intervenes, as low as .4, or even .33 or one-third; and to allow a margin or factor of safety, it would certainly seem prudent, where mere dead weight (as if of a dry or uncemented wall) is to be relied on, that this weight be made of a specific gravity of 3, or that the dam be so proportioned that its weight be three times that of the corresponding weight or pressure of water to be withstood.

The Bouzey dam should therefore have been from 100 per cent. to 150 per cent. thicker or heavier than it was, to render it reliable, with such a low specific gravity of dam construction, or the increase in strength should have been made up in some other way, as by tilting up the beds of the successive courses of masonry to an angle of about 27° with the horizon, thus doubling the resistance to a motion forward by neutralizing so much of the water pressure as necessary to lift the dam or push it up an inclined plane of that degree of slope or acclivity.

Of course it need hardly be said that with a specific gravity of dam wall of more than 2 or of between 2 and 3, as would be the case if the wall were built entirely of large sized, more or less closely-fitting blocks of stone, this would materially reduce the thickness.

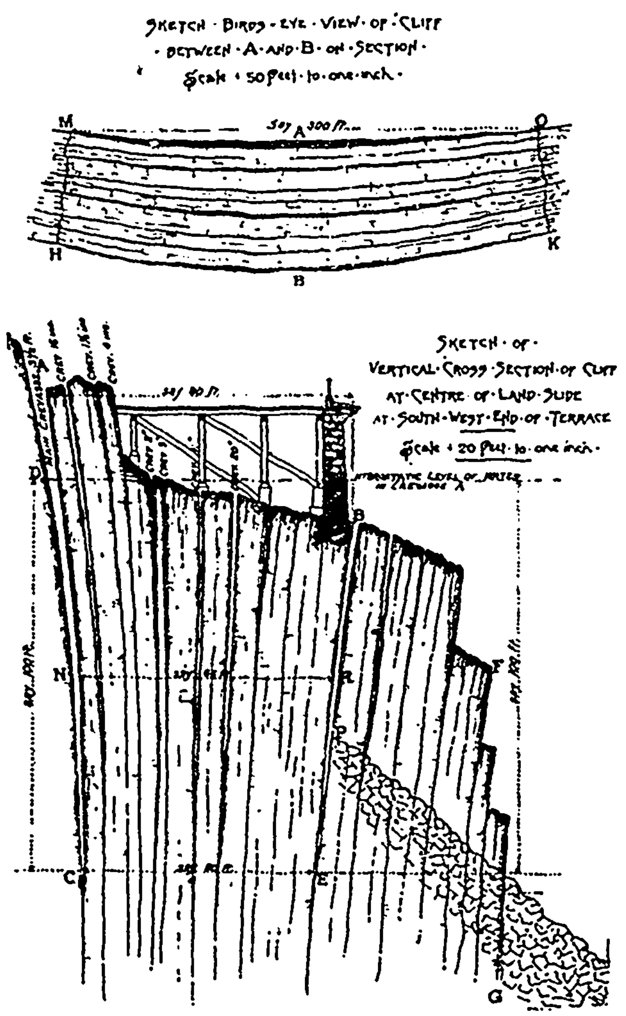
Again, the resistance may be increased by an interlocking construction, as with the Eddystone light-house in the English Channel, which would transfer the pressure and resistance from any course to the course below, and thence from course to course down to the lowermost layer abutting to the solid rock or foundation.

The theoretical dam need not be more than say three to four feet in width or thickness at top, for a good heavy coping broad enough to walk over; but top of a dam wall is generally made thick enough to allow of driving a horse and cart over it, with room for the attendant driver, say 10 to 13 feet, as it was at Bouzey. This explains the generally curved outer face of a dam wall, which theoretically might be straight or an inclined plane, since the resistance need only increase directly as the depth of water, the curve covering the increasing thickness and looking better than a break between the vertical upper and sloped lower portion of the wall.

If the stone dam could be made water tight, as can be done with the wooden one, or the water kept out of it by caulked or water-tight sheeting, its inner or up stream face could be sloped, and, as done in Canada, advantage taken of the overlying weight of water to load the dam and help keep it down.

In the foregoing considerations relating to the resistance of a dam or other retaining wall assimilated to a structure or wall built of dry stone or without cementing material or mortar, or where the mortar has lost all its binding or adhesive qualities through destruction by water infiltration, the writer has been fortunate in his knowledge and study of the Quebec land slide of 1889, an illustrated paper on which, prepared for the case in the Exchequer Court, was read by the author before the Canadian Society of Civil Engineers, and published in their transactions (Part I., vol. vii., of 1893).

THE QUEBEC LAND SLIDE OF 1889



In this case the depth of water was 100 feet, and the static pressure against the outlying portion of the cliff 46,875 tons; the mass of rock to be thrust forward was 120,169 tons (300 × 85 av. h. × 65 ft., or 1,657,500 cube ft. × specific grav. = av. 156 lbs. = 240,337,500 lbs.)

The rock to be moved was composed of strata which, originally horizontal or thereabouts, as formed of sedimentary deposits on a more or less sloping