Where in some cases the gravel is so deep that sheet piling cannot be driven through, successful sinking may at times be accomplished by an open crib loaded with rock to force it down as the excavation proceeds. This means was successfully employed during the past summer on a work with which the writer was connected. The crib was built with 6-inch sheet piling placed horizontally, strongly braced with vertical and horizontal timbers and slightly splayed outward at the bottom or cutting edge. On top of this crib the pumping machinery was placed, which consisted of three 8 × 8 centrifugal pumps together with their boilers and engines. Additional weight was added as required by placing rock on ledges around the inside of the crib. By this means a depth of 45 feet through sand, gravel and boulders was successfully accomplished.

After the excavation is complete it is often difficult to successfully seal the bottom and get the concrete up to water level. In all cases where possible, the concrete should be placed in the dry and the water kept below concrete level. In order to do this in a wet pier and at the same time prevent a large portion of the cement being pumped out, many devices are resorted to, depending on conditions and whether the water is coming from the bottom or at points higher up, so that no definite method can be laid down, as each case has to be treated separately. Experience in this, as in all parts of bridge construction, is of more value than anything that can be written.

In cases where the water cannot be controlled, to place the concrete in the dry it may be necessary to allow the pier to wholly or partially fill and deposit the concrete under water. This should be adopted only as a last resort, as nothing can be known as to how the concrete is being placed, and besides owing to the usual large amount of timber in a cofferdam, it cannot always be deposited where desired. However, where this plan is adopted, the water in the crib should first be raised to a temperature of about 70 degrees, as this insures a more rapid and better setting of the concrete. After the crib has been successfully sealed and the water pumped out, the surface of the concrete should be carefully gone over with a pick and any soft pockets removed, also the entire top carefully cleaned of the slime or mud which has settled after the concrete has been deposited.

When the pier has reached water level and the pumps dismantled the builders' troubles and anxious hours are over, as the completion of the pier then depends only upon his equipment for handling the material.

The mileage of the railways and highways compared with the total area of the province is still very small, and while many notable structures have been erected, it will be seen that bridge building must still continue for many years before it can be said there are no further bridges required.

THE HYDROSTATIC CHORD

(Continued from page 292.))

when multiplied by the corresponding tension at that point of the circle will give the value of the bending moment.

Conversely, if the bending moment be divided by the tension, the radial intercept will be the quotient and may be plotted. The value of this intercept at any angle ϕ and for any assumed head H above the top of the pipe is as follows:—

$$\frac{r\,(1/2 - y)}{\dfrac{H + r}{r} - y}$$

where r = radius of circle, and $y = 1/4 \cos. \phi + 1/2 \phi \sin. \phi$.

Any number of such curves may be plotted according to the number of different values of H assumed, and all of these will, of course, pass through the same node points.

These equilibrium shapes are not identical with the hydrostatic chord for the reason that the forces acting to produce the latter are strictly normal to the curve itself, whereas in the former case, the applied forces are always considered to be normal to the common circle for all the different equilibrium curves.

The discrepancy between the two curves for any given head is, however, so slight as to be negligible for all practical purposes. A measurable difference would scarcely be found except for very low heads, say less than one diameter above the top of the pipe, where the stresses are small and not important. After the head reaches a value of five or six diameters above the top of the pipe, the departure from a circular shape is comparatively slight, and therefore, this discussion is only particularly applicable to large pipes under low pressure.

It will be found that when the pipe is supported on a continuous saddle as is usually the case, the maximum stress is likely to be located at the top of the pipe, so that if the shell is made homogeneous no other point need be investigated for stress. If the pipe, instead of being built circular, is formed on the lines of any one of the equilibrium curves or, better still, on the lines of the true hydrostatic chord for that particular head, then the bending moments induced in it by any other head may be scaled or computed at any point by noting the length of the intercept between such curve and the curve corresponding to the head under consideration. The value of the tension at any point which must be multiplied by this intercept is given by the formula: $\gamma r \{H + r(1\text{-}y)\}$ where γ is the weight of a cubic foot of water, and the other quantities remain as before.

In arriving at the total stress it is necessary to combine algebraically the bending stresses due to weight of shell, back fill, and weight of water, and then add to them the tensile stress due to the water pressure. The bending moments in a circle when lying on a flat surface are simply expressed by the equation, $\gamma r^3 (1/2 - y)$.

When the pipe rests on a saddle the maximum stress is usually found at the top of the pipe as before stated, and although its amount is somewhat lessened by the presence of the saddle underneath, yet it is not considered advisable to rely on this, and it is best to design for stress at this point strictly as though the pipe had a very narrow saddle, or theoretically, none at all.

The above reasoning is not to be regarded as hard and fast for text-book use, and is known to be merely a close approximation.

Many interesting properties of the hydrostatic chord have been studied by the writer, and much of the mechanics relating to pipe design has been more or less thoroughly worked out, but there is so much of it that has no practical application, and so much time would be needed to co-ordinate the material that no attempt has here been made to do so.

The curve itself is not new if one considers it the same as the hydrostatic arch, with the stresses all reversed, but very little, if any, previous study of its properties and practical application has been published. Nothing of the kind has ever come to the notice of the writer.

As a matter of theoretical mechanics, and even of plane geometry, it would seem that there is here an opportunity for a little addition to the technical instruction in those branches.