uniformly distributed velocity in the water surface of surge tank. This assumption is true for the limiting cases because a short duration of the shut-down does not appreciably affect the results, as we shall see from the investigation of the influence of a shut-down of short duration. Here follow the equations for the determination of the integration constant when $t = o$:

$$R \sin \beta = -(1 - \epsilon)\, h_1 \qquad (37)$$

$$R \sin (\gamma - \beta) = +(1 - \epsilon)\, c_1 T \qquad (38)$$

The latter equation may be transformed to:

$$R \cos \beta = (1 - \epsilon)\left[\frac{T_0}{T^2} - \frac{1}{2\,T_0}\right] h_1\, T_1 \qquad (39)$$

By introducing the values in the bracketed term, we find that this term is proportional to the difference

$$\left(\frac{a}{A} - \frac{n^2 g}{2\,L}\right) \qquad (40)$$

The difference is therefore positive if $\frac{A}{a}$ is less than $\frac{2\,L}{n^2 g}$, i.e., with the same assumptions for n and g as before:

$$A < 17.5.x.a$$

This has influence on the determination of the value of β, as in the case mentioned $\sin \beta$ is negative and with $\frac{A}{a} < \frac{2\,L}{n^2 g}$ the $\cos \beta$ becomes positive, i.e., β must lie in the fourth quadrant. If $\frac{4\,L}{n^2 g} > \frac{A}{a} > \frac{2\,L}{n^2 g}$, the bracketed expression and $\therefore$ $\cos \beta$ must be negative, β lies in the third quadrant. For the last formula, we may find for the determination of R and β the equations:

$$R = (1 - \epsilon)\, h_1 \frac{T_1\, T_0}{T^2} \qquad (41)$$

$$tg\beta = -\frac{1}{T_0/T_1 - \frac{1}{4}\, T_1/T_0} \qquad (42)$$

41 is obtained by addition of the squared equations 37 and 39;

42 is the quotient of $\frac{\text{equation 37}}{\text{equation 39}}$

We see that the amount of shut-down has influence on the size of R, but not on the size of β. With respect to the occurrence of the movements (see equations 32 and 35) we find that the movement is a damped oscillation with a duration of δ secs $= 2\pi\, T_1$.

Maximum and minimum values of z or y occur when $\frac{dz}{dt} = o$.

This is the case when $\sin (\gamma - \beta - t/T_1) = o$. See Equation 35.

$$\frac{t}{T_1} = \gamma - \beta = \gamma - \beta + \pi = \gamma - \beta + 2\pi = \text{etc.} \qquad (43)$$

This value used for equation 32 gives the following maximum values:

$$z\ \max_1 = -\epsilon h_1 + Re^{-\frac{T_1}{2\,T_0}(\gamma - \beta)} \sin \gamma$$

$$z\ \max_2 = -\epsilon h_1 + Re^{-\frac{T_1}{2\,T_0}(\gamma - \beta + 2\pi)} \sin \gamma, \text{ etc.} \qquad (44)$$

and the following minimum values:

$$z\ \min_1 = -\epsilon h_1 - Re^{-\frac{T_1}{2\,T_0}(\gamma - \beta + \pi)} \sin \gamma$$

$$z\ \min_2 = -\epsilon h_1 - Re^{-\frac{T_1}{2\,T_0}(\gamma - \beta + 3\pi)} \sin \gamma, \text{ etc.} \qquad (45)$$

Due to $z = y - \epsilon h_1$

$$\frac{y\ \max_2}{y\ \max_1} = \frac{y\ \max_3}{y\ \max_2} = \dots\dots\dots\dots$$

$$= e^{-\frac{T_1}{2\,T_0}.2\pi} = \frac{y\ \min_2}{y\ \min_1} = \frac{y\ \min_3}{y\ \min_2} = \dots\dots \qquad (46)$$

The amplitude of this oscillatory motion is decreasing.

If t = infin. z becomes $-\epsilon h_1$
s becomes zero

(To be continued.)

STRENGTHENING THE FORTH BRIDGE.

When the Forth Bridge was designed, 32 years ago, the loads and the train speeds calculated for were considerably in excess of those then assumed as probable for a long period, but the advance in these respects, particularly in the weight and power of locomotives and the loads behind them, has been enormous. Therefore, although the limits have not yet been reached so far as the strength of the bridge is concerned, the directors of the Forth Bridge Company have decided further to anticipate the developments of the locomotive engineer, and to reconstruct part of the flooring and troughs in which the railway track is laid over the bridge. It has been decided at once to proceed with a trial section, to be followed by a reconstruction from end to end of the bridge. The directors have arranged for the carrying out of the work by the original builders, Sir William Arrol and Co., Limited, Glasgow, and Messrs. Baker and Hurtzig will be the engineers, in association with the engineer-in-chief of the North British Railway Company, Mr. W. A. Fraser.

It is estimated that 2,500 tons of structural steel will be required for the renewal of troughs and floor from end to end of the bridge; of this total, the addition to the weight of the present steelwork of the bridge is only 750 tons. The work will take some years to execute, as operations can only be carried on during summer months, and it is proposed not to interfere with traffic on week-days, while even on Sundays one line only will be closed.