For Instantaneous Valve closure $P_h = \rho C_p V$

RAPID CLOSURE: $(t_c < \frac{2L}{C_p})$

It is physically impossible for a valve to be closed instantaneously. Letus consider a real case where the valve is closed in a finite time t_c which is more than zero but less than $\frac{2L}{C_p}$

i.e. $t_c > 0$ but $t_c < T_r = \frac{2L}{C_p}$

SLOW CLOSURE: $(t_c > \frac{2L}{C_p})$

Slow closure will be defined as one in which the time of valve movement is greater than $\frac{2L}{C_p}$

Tests have shown that for slow valve closure, i.e. in a time greater than $\frac{2L}{C_p}$, the excess pressure produced decreases uniformly from the value at valve to zero at the intake. The water hammer pressure P_h' developed by gradual closure of a valve when $(t_c > \frac{2L}{C_p})$ is given approximately by $P_h' = \frac{2L/C_p}{t_c} P_h = \frac{2LV\rho}{t_c}$ where t_c is the time of closure.

- A pipe can be protected from the effects of high water-hammer pressure through the use of slow-closing valves, the use of automatic relief valves which permit water to escape when the pressure exceeds a certain value, or through application of surge chambers.