The surge analysis for the rising main is done using the following formulae:

$$\Delta H = \frac{\pm V * c_P}{g}$$

$$\text{and, } c_P = \frac{c_W}{\left(1 + \left(\frac{E_W}{E_P}\right) * \left(\frac{d}{t}\right)\right)^{\frac{1}{2}}}$$

Where,

ΔH= Water Hammer head (metres)

C_P = surge wave velocity; which normally ranges between 600 – 1,200 m/s depending on a number of factors including physical characteristic of the main and the pumped medium (see Table 6.8 below)

C_W = celerity (speed) of the pressure wave in a column of water – 1,425 m/s

E_w = the bulk modulus of water =2,230 N/mm^2 at 30^{o}C

E_p = modulus of elasticity of pipe wall material in N/mm^2,

g = acceleration due to gravity (9.81 m/s^2),

d = mean diameter of pipe in metres, and

t = pipe wall thickness in metres

The modulus of elasticity for different pipe materials, Ep, is presented in the Table below.

Modulus of Elasticity for different pipe materials, E_P

Material	**E_P in N/mm^2**
PE100	600-700
uPVC	2,800
Concrete	28,000
Reinforced Concrete	31,000
Pre-stressed Concrete	35,000
Ductile Iron	170,000
Steel	207,000