The phase(s) associated with the complex longitudinal ***specific*** acoustic impedance and complex longitudinal energy flow velocity ***maxima*** occur when:

$$\varphi_{z_a}(x)\Big|_{\text{maxima}} = \tan^{-1}\left(\frac{2|\tilde{R}|\sin\left(2kx+\Delta\varphi_{BA}^{o}\right)}{\left\{1-|\tilde{R}|^2\right\}}\right) = \tan^{-1}(0) = 0$$

$$= \Delta\varphi_{p_{tot}-u_{tot}^{\|}}(x)\Big|_{\text{maxima}} = \left(\varphi_{p_{tot}}(x)-\varphi_{u_{tot}^{\|}}(x)\right)_{\text{maxima}} = \varphi_{c_a}(x)\Big|_{\text{maxima}}$$

Thus, for longitudinal ***specific*** acoustic impedance and longitudinal energy flow velocity ***maxima*** associated with this situation, we see that the total/resultant complex pressure $\tilde{p}_{tot}(x,t)$ and longitudinal particle velocity $\tilde{u}_{tot}^{\|}(x,t)$ are precisely ***in-phase*** with each other, or at least by ± ***even*** integer multiples of $\pi$.

Since $\left|\tilde{z}_{tot}^{\|}(x)\right|_{\text{maxima}} = \left|\tilde{p}_{tot}(x,t)\right| / \left|\tilde{u}_{tot}^{\|}(x,t)\right|_{\text{maxima}}$ this also tells us that whenever $\left(2kx+\Delta\varphi_{BA}^{o}\right) = 0, \pm 2\pi, \pm 4\pi, \pm 6\pi ... = \pm n_{even}\pi$, the ***magnitude*** of the total/resultant complex pressure $\left|\tilde{p}_{tot}(x,t)\right|$ will also be a ***maxima***, whereas the ***magnitude*** of the total/resultant complex longitudinal particle velocity $\left|\tilde{u}_{tot}^{\|}(x,t)\right|$ will simultaneously be a ***minima***:

$$\tilde{p}_{tot}(x,t) = \tilde{A}\left[1 + |\tilde{R}|e^{i\left(2kx+\Delta\varphi_{BA}^{o}\right)}\right]\cdot e^{i(\omega t-kx)} = \tilde{A}\left[1 + |\tilde{R}|e^{\pm i n_{even}\pi}\right]\cdot e^{i(\omega t-kx)}$$

$$= \tilde{A}\left[1 + |\tilde{R}|\left\{\cos(\pm n_{even}\pi) + \cancel{i\sin(\pm n_{even}\pi)}\right\}\right]\cdot e^{i(\omega t-kx)} = \tilde{A}\left[1 + |\tilde{R}|\right]\cdot e^{i(\omega t-kx)}$$

and:

$$\tilde{u}_{tot}^{\|}(x,t) = \frac{\tilde{A}}{\rho_o c}\left[1-|\tilde{R}|e^{i\left(2kx+\Delta\varphi_{BA}^{o}\right)}\right]\cdot e^{i(\omega t-kx)} = \frac{\tilde{A}}{\rho_o c}\left[1 - |\tilde{R}|e^{\pm i n_{even}\pi}\right]\cdot e^{i(\omega t-kx)}$$

$$= \frac{\tilde{A}}{\rho_o c}\left[1 - |\tilde{R}|\left\{\cos(\pm n_{even}\pi) + \cancel{i\sin(\pm n_{even}\pi)}\right\}\right]\cdot e^{i(\omega t-kx)} = \frac{\tilde{A}}{\rho_o c}\left[1 - |\tilde{R}|\right]\cdot e^{i(\omega t-kx)}$$

$$\Rightarrow \quad \left|\tilde{p}_{tot}(x,t)\right| \equiv \sqrt{\tilde{p}_{tot}(x,t)\cdot\tilde{p}_{tot}^{*}(x,t)} = |\tilde{A}|\left[1 + |\tilde{R}|\right] \qquad \text{for } |\tilde{R}| = 1: \ \left|\tilde{p}_{tot}(x,t)\right| = 2|\tilde{A}|$$

$$\Rightarrow \quad \left|\tilde{u}_{tot}^{\|}(x,t)\right| \equiv \sqrt{\tilde{u}_{tot}^{\|}(x,t)\cdot\tilde{u}_{tot}^{\|*}(x,t)} = \frac{|\tilde{A}|}{\rho_o c}\left[1 - |\tilde{R}|\right] \qquad \text{for } |\tilde{R}| = 1: \ \left|\tilde{u}_{tot}^{\|}(x,t)\right| = 0$$

"Pure" standing wave!!!

In general, for arbitrary values of *x*, ***minima*** of the complex longitudinal ***specific*** acoustic impedance $\tilde{z}_{a_{tot}}^{\|}(x)$ and the complex longitudinal energy flow velocity $\tilde{c}_{a_{tot}}^{\|}(x)$ will occur whenever $\left(2kx+\Delta\varphi_{BA}^{o}\right) = \pm 1\pi, \pm 3\pi, \pm 5\pi ... = \pm n_{odd}\pi$, *i.e.* whenever $\cos\left(2kx+\Delta\varphi_{BA}^{o}\right) = -1$, and $\sin\left(2kx+\Delta\varphi_{BA}^{o}\right) = 0$, then: