The effect of prestress force and eccentricity on the natural bending frequencies of prestressed concrete structures

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\textbf{Abstract}

The effect of prestress force on the natural frequencies ($\omega_n$) of prestressed concrete (PSC) structures is a topic that has been widely debated. It has been argued that the natural frequency of PSC structures decreases with increasing prestress force, $N$ (Miyamoto et al., 2000), due to the "compression softening" effect. Other researchers have argued that $\omega_n$ increases with increasing $N$ (Saiidi et al., 1994). Some argue that $N$ has no effect on $\omega_n$ (Hamed and Frostig, 2004).

Impact hammer testing has been conducted on post-tensioned concrete beams for varying $N$ and for various straight-profile prestress strand eccentricities ($e$). Experimental modal analysis has subsequently been conducted. From the frequency response functions (FRFs) obtained, the experimental values of $\omega_n$ have been identified for various $N$ and $e$. Statistical analysis has been conducted on the data to determine if the effects are statistically significant. Impact hammer testing has also been conducted on externally axially loaded steel RHS sections and the results have been benchmarked against those for the same section that has been prestressed with an internal tendon. The validity of the aforementioned "compression softening" effect has therefore been determined.

The effect of $N$ on $\omega_n$ of PSC structures has many implications, especially for PSC bridge girders and for post-tensioned concrete wind turbine towers. The Eurocode 2 equation for prestress loss over time is well established. If the relationship between $\omega_n$ and $N$ can be fully established then the change in $\omega_n$ due to decreasing $N$ over the design life of a PSC structure can be determined.

\textbf{References}

