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

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Abstract

The effect of prestress force on the natural frequencies (ω_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 ω_n increases with increasing N (Saiidi et al., 1994). Some argue that N has no effect on ω_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 ω_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 ω_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 ω_n and N can be fully established then the change in ω_n due to decreasing N over the design life of a PSC structure can be determined.

References

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