Protection Assessment of Lightning Strikes on Concrete-Steel Structures Simulated at Full Scale

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The ability for a structure to provide adequate shielding from the fields induced by lightning attachment is of critical importance. Steel-reinforced concrete structures offer some protection. However, these structures may contain electrical discontinuities in the rebar reinforcement that potentially reduce the structure's shielding capacity.

The induced electric and magnetic fields inside a full-scale model of a steel-reinforced concrete structure with a soil overburden are simulated in electromagnetic software to determine the effective shielding provided by the structure against a lightning protection level (LPL) category one strike. The strike attachment point and strike type (positive/negative) are varied with the fields internal to the structure, evaluated to understand the spatial relation of the strike attachment point on field magnitude. Following NFPA 780, regulation defining lightning protection systems (LPS) for buildings, a model incorporating an overhead catenary wire is analyzed to determine the field mitigation provided by the LPS. The moisture content of the structure's concrete frame and surrounding soil, as well as soil composition, are investigated to determine their influence on the structure's internal field levels during attachment. Additionally, the strike rise time is varied to determine the shielding capability of the structure as a function of the strike's frequency. The simulation models are analyzed to determine a parameter space that promotes an electromagnetically resilient structure against a worst-case attachment scenario.
