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Civil Engineering Structures with FRPS Have: A Higher Ductility

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Editorial

Parkinson's, the ability of a material, or a component built from it, to sustain its stress or stress resultant capacity over a wide range of deformations is referred to as ductility. Its origin is derived from the Latin term ductile (the ability of metals to be drawn into wires). This feature is deceiving because, despite its simplicity, it is the foundation of several essential structural engineering ideas. For instance, for a given load, a sufficiently ductile structure produces a unique, path independent ultimate limit state (ULS), with the ductility-driven internal stress redistribution process decreasing all self-equilibrating stress resultants (SESRs) to zero at the ULS. Owing to uncertainties in quantifying the structural variables which induce self-equilibrating stress resultants, these SESRs and the associated movements of the structure are difficult to quantify. As a result, ductility is forgiving in that it allows a structure to absorb unknown but considerable additional motions associated with self-equilibrating stress resultants near the ULS while obviating the need to evaluate such resultants at the ULS. This means that the ULS can be reliably determined using fast analyses that either focus solely on the final state (mechanism analysis) without considering pre-ULS behaviour, or use simple material models to replace the complex material nonlinearities (cracking, compression softening, yielding, etc.) exhibited by actual structures en route to the ULS.

The powerful bound theorems of plasticity are derived from these principles. Furthermore, ductility adds to resilience by allowing stable stress redistributions that allow a structure to continue carrying load without collapsing after damage has occurred. Other advantages of ductility include the ability to dissipate energy during earthquakes and the ability to create substantial deflections in the lead-up to failure, which serves as a signal of impending failure. Steel has long been a popular source of ductility in civil engineering projects. Fiber reinforced polymers (FRPs) are materials that are made up of (mostly glass or carbon) fibres embedded in an epoxy or other resin. FRPs have revolutionised the aerospace sector by supporting a new generation of lighter, more fuel-efficient aircraft due to their better strength-to-weight and stiffness-to-weight ratios, as well as their corrosion resistance. FRPs have enormous potential to alter the construction industry by ushering in a new class of light, quickly constructed, durable bridges, buildings, and other civil engineering structures, owing to the above characteristics and their simplicity of production into modular parts.

FRPs, on the other hand, differ from steel in their behaviour. FRPs, in particular, are linear elastic until failure and do not have a ductility plateau on their stress–strain charts. To support these structural applications of FRPs, new design paradigms must be developed. To that goal, numerous experimental and theoretical studies into FRPs are being carried out worldwide, both for reinforcing existing structural components and for new-build applications. The low ductility subject is explored in some of these researches. The 14 papers in this special edition of the respected Construction and Building Materials magazine include a wide range of investigations on the ductility characteristics of structural components or structures containing FRPs by leading academics from across the world [1-5].

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Conflict of Interest

The Author declares there is no conflict of interest associated with this manuscript.

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