Self-powered magnetorheological elastomer base isolation system with self-tuning characteristics

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ABSTRACT

Base isolator is one of the most adopted and effective means of mitigating unwanted and harmful vibrations to protect buildings and other key civil infrastructure from seismic events [1,2]. However, a critical drawback of such a system is its lack of adaptability and flexibility, i.e. once a base isolator system has been designed and installed it can only react passively to whatever happens and has no capacity to adapt to any changes in itself or types of earthquakes it encounters. As a result, a base isolation system that is effective against one type of earthquakes may be less effective or even has adverse effects for another [3]. For these reasons, an adaptive base isolation system that can optimally adjust itself in real time to maintain effective under varying conditions, including different types of earthquakes and unknown changes in the structure itself, is the ultimate goal for researchers to pursue. On the basis of the above motivation, this paper developed a new self-tuneable MRE base isolation system, which mainly consists of a compact self-powering component and stiffness softening MRE isolator. The stiffness softening MRE isolator mainly composes of a laminated MRE structure and a permanent magnet-electromagnet system. The permanent magnet inside the isolator can energise the MRE to be hard at all times without consuming power, while the solenoids can produce an opposite electromagnetic field to weaken the overall magnetic field and thus reducing the lateral stiffness of the MRE isolator. The stiffness softening MRE isolator will be powered directly by the self-powering component and then the whole system will demonstrate self-tuning capability. Specifically, during daily operation, the self-powering component is not activated and the new base isolator operates in passive hard stiffness mode to guarantee the stability of the building without any requiring power. When earthquake happens, the self-powering element will be activated automatically to power the electromagnet to soften the isolator and then the building can be decoupled from the moving ground, still without consuming power. In addition, the new isolation system has fail-safe characteristic, which means it still can operate as a passive hard isolator to guarantee the stability of the building and conduct comparable performance with a passive isolation system even its control system fails. In summary, this intelligent self-tuneable isolation system can operates like a passive isolator and will be more likely to gain acceptance from construction and building industries.

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