CEMENT COMPOSITES REINFORCED BY SPATIAL PLASTIC ELEMENTS CREATED BY 3D-PRINTING

Abstract

3D printing, over the last two decades, has become one of the fastest growing and most promising technologies. The emergence of new concepts and technological solutions of 3D printing is dictated by the growing need to print materials that perform construction, thermal insulation and lighting functions in buildings. The series of publications presented in the dissertation concerns the use of 3D printing of plastics for construction applications - unconventional internal reinforcement and permanent formwork serving as external reinforcement. The first work concerns a review of the latest achievements in 3D printing of plastics for construction industry. Practical applications of such solutions and challenges in their further research are discussed. Before starting the actual research, an experimental plan was prepared and a cement matrix was selected for filling fractal columns and complex spatial reinforcement. The next three works presented the concept of concrete-plastic columns. The cross-sections of 3D-printed plastic column formworks represented three types of shapes: the most common, rare and impossible to implement using traditional formwork (based on fractals).The prepared formwork plastic was filled with standard mortar (mortar adopted as a cement matrix (with and without the addition of steel fibers)) acting as ordinary concreto. The load-strain characteristics were investigated with particular emphasis on the destruction and energy dissipation characteristics for all concrete columns. The last stage of the research concerned 3D printed gyroids, which were used as spatial reinforcement elements, unattainable using traditional reinforcement techniques. It was proved that concrete-plastic columns were characterized by quasi-plastic behavior during the destruction process. The results obtained proved that it is possible to replace traditional formwork and ordinary concrete reinforced with steel rods and stirrups with automated 3D printing based on concrete reinforced with plastics and steel fibers. Concrete structures that may be exposed to accidental loads from impacts, shock waves, water waves, vibrations, earthquakes, explosions, etc. are the most likely future applications of concrete elements reinforced with spatial plastic elements.

Keywords: 3D printing, plastic, formwork, reinforcement