Chapter 10
Advanced Composites for Civil Engineering Infrastructures

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ABSTRACT

The development of advanced composites not only enhances strength, ductility, durability of materials, and endows materials with the multifunctional property, but also reduces the construction cost and promotes civil engineering infrastructure to make sustainable development. In this chapter, several representative advanced composites with abundant research achievements and wide applications are systematically introduced with regard to cementitious composites, fiber-reinforced polymer composites, novel thermally functional composites, and 3D printing composites in terms of their definitions, properties, research progress, and applications in civil engineering infrastructures.

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INTRODUCTION

Civil engineering infrastructures in a narrow sense involve buildings, bridges, roads, railways, tunnels, airports and other engineering facilities for living, transportation and production. Not only are civil engineering infrastructures for human beings the essential facilities of production and life, but also reflect the development of society and civilization. With the improvement of people's living standard and the progress of engineering technology, the demands for safer, smarter, more comfortable, more beautiful and more durable civil engineering infrastructures are growing dramatically. After decades of services, the existing civil engineering infrastructures are confronted with serious problem of material deterioration and functional deficiency. Furthermore, the sustainable development of civil engineering infrastructures has become an urgent issue in the future. Obviously, conventional building materials are difficult to meet the above challenges. Firstly, the defects of conventional materials are likely to result in a risk of structural failure and durability deterioration, such as the brittle failure of concrete and the corrosion of steel. Secondly, most traditional building materials are non-renewable and energy-intensive, thus they put huge pressure on environment with too much pollutant discharge and block the sustainable development of civil engineering infrastructures. Thirdly, modern cities tend to be more convenient, more humanized and smarter, which urges for new building materials possessing not only excellent mechanical properties but also multifunctional properties in various aspects like electricity, heat, sound, light and magnetism (Han et. al., 2015; Han & Zhang, 2017). Therefore, new advanced composites, such as high-performance concrete, multifunctional and smart cementitious composites, green and environmental civil engineering composites, are desired to meet the above demands in civil engineering infrastructures.

In this chapter, several representative advanced composites with abundant research achievements and wide applications are systematical introduced with regard to cementitious composites, fiber reinforced polymer composites, novel thermally functional composites and 3D printing composites, in terms of their definition, properties, research progress and application in civil engineering infrastructures.

CEMENTITIOUS COMPOSITES

During development history of civil engineering composites, cementitious composites become the main and irreplaceable construction materials because of their strong adaptability and low cost. However, poor ductility and single function of cementitious composites bring the challenges and opportunities for advanced cementitious

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