Single-layer crossover CFRP lamella cable-supported roof without inner ring

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Abstract

Carbon fiber reinforced polymer (CFRP) is an advanced composite material with many advantages, such as high strength, light weight and excellent corrosion and fatigue resistance. This makes it suitable for some spatial structures like single-layer spoke-wheel cable roof replacing conventional steel cables. However, CFRP is an orthotropic material, i.e. its strength and modulus perpendicular to the fiber direction are much lower than that along the fiber direction. This causes the difficulty of anchoring CFRP cables, and consequently the difficulty of handling the inner ring node of the single-layer spoke-wheel CFRP cable roof. In view of this, the authors propose a novel design in this paper. It uses a double-curved outer ring and CFRP lamellas as cables which cross each other obliquely to form a single-layer cable-supported roof without inner ring. At the intermediate nodes, the CFRP lamellas are stacked pairwise and gripped by simple clamps. This structure has two main merits: 1) the difficulty of connecting CFRP cables is enormously eased; 2) the robustness and progressive collapse resistance of the structure are significantly improved. A 100 m diameter single-layer crossover CFRP lamella cable-supported roof without inner ring was designed and the finite element analysis was performed. The results show that the expected form and force of the crossover CFRP lamella cable system can be reasonably achieved and the damage of one CFRP lamella will not lead to unexpected huge displacement or progressive collapse of the whole structure.

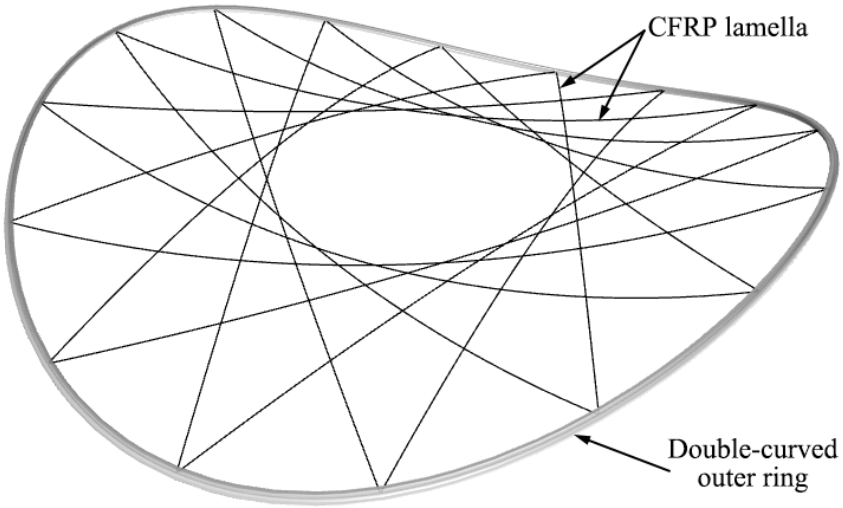

Figure 1: Single-layer crossover CFRP lamella cable-supported roof without inner ring