Experimental investigations on Structural Behaviour of Two-layer-stacked ETFE film Square Planar Structure Under Normal Pressure Loading

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ABSTRACT

ETFE foil features unique architectural physics and mechanics properties, and has been widely used over the world. Thickness of ETFE film is usually 150-250μm, this will realize the better trade-off performance, including manufacture procedure, mechanical behaviour, film production, etc[1-3]. Since diverse application condition, such as fairly large span of membrane, heavy snow, strong wind, the membrane structure composed of ETFE foil single layer could not meet structural performance. Even some supplier could produce bigger thickness foil up to 500μm, as proved difficulty manufacture of welding and packaging. Two-layer-stacked ETFE film instead of single layer was proposed and adopted in some large engineering projects[2-3]. Two-layer-stacked ETFE film is composed of two identical layers of different thickness pilled up to provide large loading capacity, and designed from rare empirical engineering knowledge. However, there are no solid research published yet. This paper will firstly report the preliminary experimental results of two-layer-stacked ETFE film square planar structure under normal pressure loading.

Firstly, the two-layer-stacked ETFE film conception and application are outlined. Two-layer-stacked ETFE film is composed of two layers of different thickness, and used as common top or bottom layer of cushion and tensile membrane, as well as adopted in classic 3D cutting and planar cutting method. Two layers have identical overall dimensions, welded at peripheral rim to construct a membrane structural component without hard evacuating between two layers, and inner cutting and seaming should be in misalignment with at least one seam width to avoid seam repeat to result in too thickness to weld hardly.

Secondly, series experiments have been designed and performed on two-layer-stacked ETFE film square planar structure under normal pressure loading. The planar size is 1500mm×1500mm. Two layers are 150μm and 100μm to constitute a 250μm two-layer stacked film. Planar cutting and 3D cutting are both employed with nearly symmetry of four pieces. For comparative base, single layer 250μm film also is used to perform the counterpart experiments. Three engineering manufacturers provide the same design model to evaluate the effects of different manufacturing procedures. Loading simulation compartment (LSC) is developed, mainly consist of 1.5m×1.5m×1.8m thin-walled steel grid box with open cover, and inflation and evacuation module, as can achieve normal suction and pressure loading on the membrane surface[4-5]. Photogrammetry and laser meteor are used to measure the deformation and overall geometry form.

Finally, the preliminarily analysis of experimental results are summarized. The two-layer-stacked ETFE film of 250μm exhibits structural behaviour similar to the single layer 250μm. The ultimate loading capacity of the two-layer-stacked ETFE film is over 0.8 times of the single layer, as depends on manufacture. The micro chamber is found undoubtably exist, and the close volume and its effects dominate mainly the structural mechanical performance of the two-layer-stacked ETFE film. The present research will add the knowledge of understanding the structural behaviour of two-layer-stacked ETFE film, and extend engineering application of ETFE membrane structures.

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