COMPRESSIBILITY AND RELAXATION OF FIBER REINFORCEMENTS DURING COMPOSITE PROCESSING

김 영특

삼성중공업
종합기술연구소
중장비 시험연구실

ABSTRACT

In many reinforced composite manufacturing processes it is necessary to compact the fiber materials to obtain the desired fiber/resin ratio in the finished part. Detailed knowledge of applied surface force versus material fiber volume is particularly important in processes such as pultrusion, resin transfer molding and compression molding. The force required to compact a stack of reinforcing material is strongly dependent on the type of fiber used and its material form. Complicated interactions are possible, particularly when mixtures of unidirectional, oriented cloth and random fiber mats are used. This paper will present results of an experimental and analytical investigation of the response of various dry reinforcing materials subjected to compressive forces applied normal to their principle plane. Experiments were conducted by applying up to 8.6 MPa normal force to thick stacks of E-glass, graphite cloth, mat and unidirectional material and combination of two different fiber orientation. Pressure versus fiber volume data were generated for both individual materials and various combinations. Experimental results were compared to analytical predictions. Data showed that the force versus deformation is very strongly dependent on the details of the fiber form or forms being used. There is structural relaxation during fiber compression. Relaxation is very related to fiber orientation, span length and fiber breakage during compaction. Relaxation behavior decreases with fiber alignment. Random mats and 0/90 cloth show much more relaxation than unidirectional fibers. Data of relaxation is very well fitted with a Maxwell-Wiechert viscoelastic model.