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ScienceDirect

Procedia Manufacturing 22 (2018) 35–40

Procedia MANUFACTURING

www.elsevier.com/locate/procedia

11th International Conference Interdisciplinarity in Engineering, INTER-ENG 2017, 5-6 October 2017, Tirgu-Mures, Romania

An advanced high rigidity thin sandwich composite laminate with COREMAT and dissimilar skins

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Abstract

Within this paper, the most important mechanical properties determined in simple tensile tests of a thin sandwich composite laminate with nonwoven polyester mat used as core and dissimilar skins are presented. This nonwoven polyester mat known as COREMAT increases the overall stiffness of a composite laminate by the increase of the entire thickness of the laminate avoiding stacking a specific number of layers. The skins are dissimilar, the upper one has a polyester reinforced RT glass fabric and the lower one is a gelcoat layer. Following main mechanical properties have been determined: stiffness, Young's modulus, load/stress/strain at maximum load, load/stress/strain at maximum extension, load/stress/strain at minimum load, load/stress/strain at minimum extension, tensile strength, work to maximum load/extension, work to minimum load/extension and load/stress at break.

Peer-review under responsibility of the scientific committee of the 11th International Conference Interdisciplinarity in Engineering.

Keywords: nonwoven polyester mat; sandwich; composite laminate; glass fabric; COREMAT.

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2351-9789
Peer-review under responsibility of the scientific committee of the 11th International Conference Interdisciplinarity in Engineering.
10.1016/j.promfg.2018.03.007

1. Introduction

For a sandwich structure, the core represents the most important part which influences the overall structure's stiffness and flexural rigidity. The COREMAT material is a random oriented noncontinuous nonwoven polyester mat which contains microspheres that prevent excessive resin consumption in the manufacturing of thin composite laminates. The nonwoven polyester mat is a soft material which presents excellent resin impregnation and high drapeability and therefore is suitable for complex shapes. It is most often applied against the gelcoat layer to create a superior surface finish for instance on hull sides and to prevent the appearance of the glass fibres reinforcement especially when dark gelocoats are used. This material has a good compatibility with polyester, vinylester and epoxy resins and is suitable to use it for common composite laminate processes like hand lay-up and spray-up. The COREMAT material is used to increase the overall stiffness of the whole sandwich structure avoiding stacking together a high number of layers to obtain the same stiffness for a composite laminate [1]. The most important characteristics of a sandwich structure using this kind of core are:

- Weight saving;
- Important saving in resin and reinforcement consumption;
- Overall stiffness increase of the whole sandwich structure;
- Fast build of the structure's thickness;
- Superior surface finish.

Usually, composite laminates present quite low stiffness and flexural rigidities. For pre-impregnated composite materials with more than two phases, to predict their elastic properties, averaging and homogenization methods can be used [2]. For a three-phase polymer matrix composite material subjected for instance to static cyclic tensile-compression loadings, hysteresis phenomena can appear [3]. It would be very interesting to quantify the influence of the COREMAT material in the overall hysteresis of a composite laminate with this kind of core. For a multiphase polymer matrix composite material with ceramic filler, the same hysteresis phenomena have been determined on samples subjected to static cyclic loadings [4]. For unidirectional reinforced polymer matrix composite laminates subjected to off-axis loading systems, their elastic properties vary as a function of their plies sequence [5], [6]. For a thin sandwich structure with COREMAT material, a thermomechanical response including the coefficients of thermal expansion have been determined [7].

2. Tests to determine the properties of the new material

Following plies sequence has been used in the manufacturing of the composite laminate:

- 1 x RT500 glass roving fabric;
- 2 x RT800 glass roving fabric;
- 1 x 450 g/m2 chopped glass fibres mat;
- Nonwoven polyester mat as core;
- 1 x 450 g/m2 chopped glass fibres mat;
- A gelcoat layer.

From the laminate plate, twelve specimens have been cut according to SR EN ISO 527-4: 2000 and subjected to tensile test until break occur. The composite laminate plate has been manufactured at Compozite Ltd., Brasov and tested in the Materials Testing Laboratory within Transilvania University of Brasov, Romania. The materials testing machine used in tests is a LS100 Plus type, produced by Lloyd Instruments, UK, with following characteristics:

- Force range: up to 100 kN;
- Test speed accuracy: < 0.2 %;
- Load resolution: < 0.01 % from the force cell;
- Extension resolution: < 0.1 microns;
- Type of force cell: XLC-100K-A1;
- Extensometer: type Epsilon Technology;
- Analysis software: NEXYGEN Plus.

Test and specimens features are:

- Length between extensometer's lamellae: 50 mm;