Interlaminar Stress and Delamination Effect on Load Capacity of Stratified Composite Materials

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Composite materials fatigue is a process which causes early failure or damage of variable loading subjected structure. Prediction of life period of composite materials uses different deterioration models. Quantifying of interlaminar stress and delamination can be underlined on load capacity of stratified composite materials subjected to fatigue.

Keywords: composite materials, fatigue, interlaminar stress, delamination, load capacity

The most important way of stratified composite materials deterioration is delamination [1]. The way of producing this phenomenon and its influence over material future behaviour in service greatly depends of loading case and local stresses [2, 3].

Evaluation of interlaminar stresses and revealing the way delamination is produced and its effect over residual strength and stiffness are the objectives of present work. Theese two elements gives the load capacity of the structure [4].

Experimental part

Experiments were used in order to determine interlaminar stresses and delamination effect over the load capacity of stratified composite materials [5]. Test – pieces were realized from unidirectional, symmetrical or roving armoured layers.

The matrix was Nestrapol 450, polyesteric resin, and the armor was fiber glass fibers for all test – pieces.

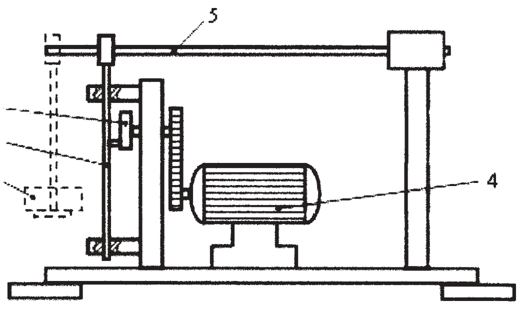

Fig. 1. Static and fatigue straight cap piece loading device
1-excentric; 2-excentric rod; 3- mass; 4 - electric motor; 5 - test - piece

Static loads were the first loads. Interlaminar stresses were determined using mass included strain gauges. The interlaminar stresses are adimensional by reporting them to normal stresses. Two sections were considered for interlaminar stresses evaluation, at 0.25l and 0.75l from free – end of the straight cap piece as figure 2 shows.

Cross unidirectional [0/90/0/90/0] stratified composite material and five layers roving stratified material were used for test – pieces determinations.

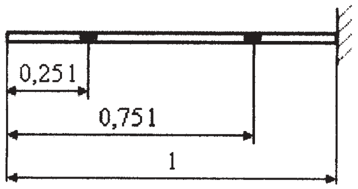

Fig. 2. Mass included strain gauges position in static load case

Bending fatigue using figure 1 presented device is the second test cagory.

Revealing the delamination process over life span of the test – piece and material residual strength and stiffness determination are the objectives of tests.

Residual strength and stiffness determination using half initial delaminated in the free – end of the straight cap pieces static load subjected are other approaches in composite materials study.

Results and discutions

Figure 3 presents the results of static loads.

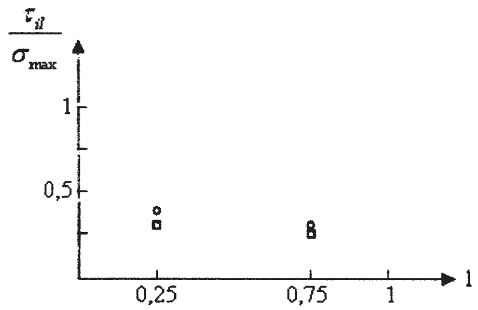

Fig. 3. Interlaminar stresses in static loaded straight cap pieces
o - cross unidirectional stratified; □ - roving stratified

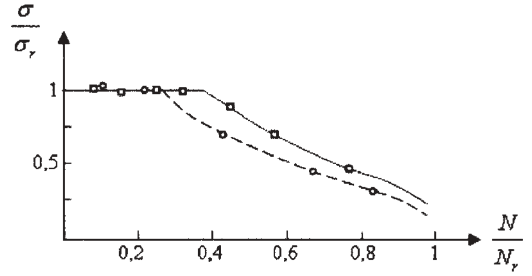

Fig. 4. Residual strenghth of fatigue subjected straight cap pieces
o - cross unidirectional stratified; □ - roving stratified

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Table 1
RESIDUAL STRENGTH AND STIFFNESS OF STATIC LOADED STRAIGHT CAP PIECES WITH 50% DELAMINATION

	Cross unidirectional stratified 50% delaminated	Roving stratified 50% delaminated
Adimensional residual strength	0.72	0.78
Adimensional residual stiffness	0.55	0.68

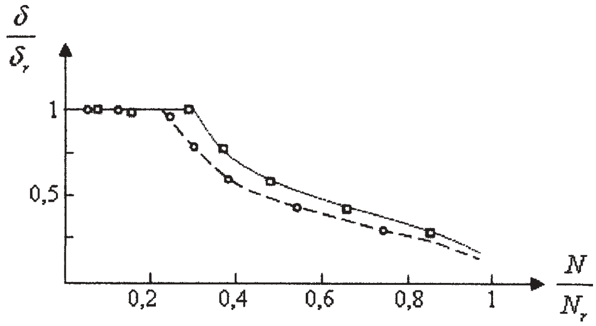

Fig. 5. Residual stiffness of fatigue subjected straight cap pieces
o - cross unidirectional stratified; □ - roving stratified

Figure 4 presents residual strength evolution and figure 5 presents residual stiffness evolution.

The observations revealed that delaminating process occurs from free – end to embedded one. Planeity loosing of transverse sections and implicit longitudinal gliding near free – end while blocking them at the embedded end are the explanations of above described phenomenon.

Table 1 presents residual strength and stiffness of static loaded straight cap pieces with initial 50% free – end length imposed delamination.

Conclusions

Interlaminar stress in bended straight cap pieces is 30% – 45% normal stress.

Experiences focusing delamination revealed the appearance of this phenomenon in areas where these are not constructive blocked. In consequence, in order to avoid the above mentioned phenomenon we must consider solutions which block longitudinal gliding.

Residual strength and stiffness are maintaining at the initial level at fatigue loads in first third of life span. This information is highly important in destination establishing and trust level of fatigue subjected stratified composite materials structures.

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