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BEHAVIOUR OF GLASS WOVEN REINFORCED THERMOPLASTIC LAMINATES UNDER UNIAXIAL CYCLIC LOADING

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The presented work aims at broadening knowledge regarding the behaviour of glass woven reinforcing the thermoplastic laminates under low and high uniaxial cyclic loading.
The fatigue tests were carried out on specimens composed of acrylic matrix and four plies of woven provided in the form suitable to the impact tests. Dimensions of the measurement part of the specimens were equal to 100 mm x 100 mm x 2mm. Cyclic loading was performed under force control with the frequency of 2 Hz. The sinusoidal loading regime was characterized by R = 0,1. Boundary conditions were set in the loading controller to limit maximum and minimum of force during cycling. Six stress levels were taken into account. For the first three tests, the stress level of loading cycles was planned to be below the yield point. In the second group, a similar program was arranged, however, with the value of maximum force giving a stress above the yield point. All tests were carried out using an extensometer with the strain range of ±0.2. The loading cell was calibrated in the range of ±250 kN.
As a result of tests carried out on the GFRP $[90°]_4$ under stress amplitudes lower than the yield point an effect of ratcheting was observed. In the experimental program the Young's modulus variations were monitored. Almost 25% reduction of the initial stiffness was detected for the material in question. This value corresponds to stable width of the hysteresis loop [2], and it was subsequently applied to predict fatigue life using the Manson–Coffin–Basquin curve.

In conclusion, it has to be emphasised that the GFRE $[90°]_4$ exhibited the visible effect of strain-softening observed during fatigue, especially in the case of several last cycles. The specific structure of glass woven (formed by interlacing the longitudinal and transverse yarns (warp and weft, respectively) reinforcing acrylic thermoplastic resin, is presumably responsible for such behaviour during fatigue. It produces four types of failures in 2D woven laminates: intra-yarn cracks in the yarns oriented transversely to the loading direction (1), inter-yarn decohesion between longitudinal and transverse yarns (meta-delamination) (2), fiber failure in longitudinal yarns (3) and yarn failure (4).

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