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AN EXPERIMENTAL STUDY ON THE BEARING STRENGTH OF COMPOSITE LAMINATES

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ABSTRACT

The increasing number of successful applications of *Fibre Reinforced Polymer* (FRP) laminates in realizing civil structures as well as their subsequent technological development have attracted the attention of the international scientific community, with particular interest being given to understanding in greater detail the particular aspects connected to the use of new materials [1]. In particular the problems connected to the design and verification of structural bolted joints for civil engineering structures is a complex and important theme that has not been adequately studied. Both theoretical as well as experimental studies have been recently carried out by researchers working in the field of civil engineering in relation to the various types of bolted joints. It worth taking into account the results obtained by Camanho and Matthews [2], Ekh, Schön and Melin [3, 4], Hassan, Mohamedien and Rizkalla [5], Ireman [6], Kelly and Hallström [7], Li, Kelly and Crosky [8], Lie, Yu and Zhao [9], Starikov and Schön [10], Vangrimde and Boukhili [11, 12], Xiao and Ishikawa [13], Yan, Wen, Chang and Shyprykevich [14].
The results of these studies have highlighted the typical failure modes of FRP bolted joints, identifying the main factors as being: 1) stacking sequence of the laminates; 2) joint geometry: bolt diameter, plate width, end distance and thickness of the composite member; 3) matrix type and fibre nature.
The objective of this paper is to investigate on the bearing failure mode of composite laminates to be used for civil engineering applications and, in particular, to obtain experimental data on the effects of fibre inclination angle and laminate stacking sequence on the bearing strength.
To perform the experimental investigation, were tested two types of laminates: unidirectional and cross-ply. In particular the stacking sequence of the unidirectional laminates was [CSM/0_8/CSM], while for the cross-ply laminates were used two different stacking sequence. These latter were: [(CSM/0_6/90_6)$_s$] and [(CSM/0_3/90_3)$_2$]$_s$, where the number of plies and the thickness was constant.
The experimental results have shown that the bearing strength depends significantly on fiber inclination angle respect to external load direction for both types of laminates considered. In particular, in the case of unidirectional laminates the experimental analysis carried out have underline that the maximum value of bearing strength was obtained when external load direction was parallel to that of fibers. As expected the lowest value was reached when the load direction was orthogonally to fiber one, with a

total reduction of the bearing strength equal to 32%. Also in the case of cross-ply laminates analysis have shown a reduction of bearing strength when fiber inclination angle increased respect to the external load direction. In this case the lowest value of the aforementioned strength was reached for an angle equal to 45°. Furthermore, the experimental analysis on cross-ply laminates have also underline that in terms of bearing strength, the difference between the two stacking sequence considered is no more than 5% when the laminate thickness and the number of plies is constant.

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