Bearing tests of specimens manufactured from chopped C/PPS pellets

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Abstract: Presented article deals with description and evaluation of bearing tests of specimens manufactured from C/PPS pellets (random orientation) with titanium inserts. These inserts has two versions - cylindrical (C) and cylindrical with groove (G). Main goal of the tests is to evaluate bearing strength of the material which will be applied in the FE simulation of the real parts in construction of aircraft door and for biomedical application (part of the external fixator).

Keywords: bearing test; randomly reinforced composite; thermoplastic matrix; chopped pellets

1 Description of the Experiment

Prepared experiment was based on ASTM D5961 standard [1] for specimens with random reinforcement (randomly reinforced chopped C/PPS pellets in our case – see [4] for details) with titanium insert. Failure modes of tested specimens can be seen in Fig. 1. Specimens were manufactured in Latecoere Czech Republic. Bearing strength σ_b is defined as loading force F divided by the hole diameter D multiplied by laminate thickness t

$$\sigma^b = \frac{F}{Dt}. \tag{1}$$

Definitions of bearing strength are based on limit bearing strain values, ultimate strength, first decrease during loading or the beginning of nonlinear behavior [3]. Standard [1] defines two bearing strengths - first one is "Initial Peak Bearing Stress" which corresponds with the first decrease during loading, second one is "Offset Bearing Stress" and its computation can be described with the use of the stress/strain graph shown in Fig. 2.

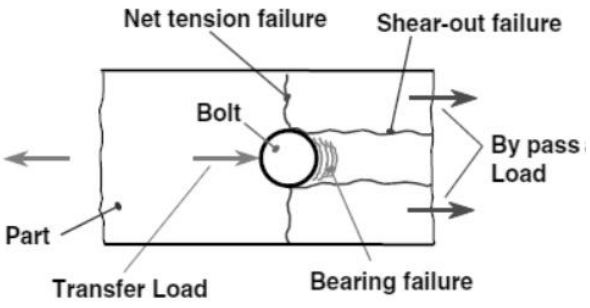

Fig. 1: Failure modes of loaded specimen [2].

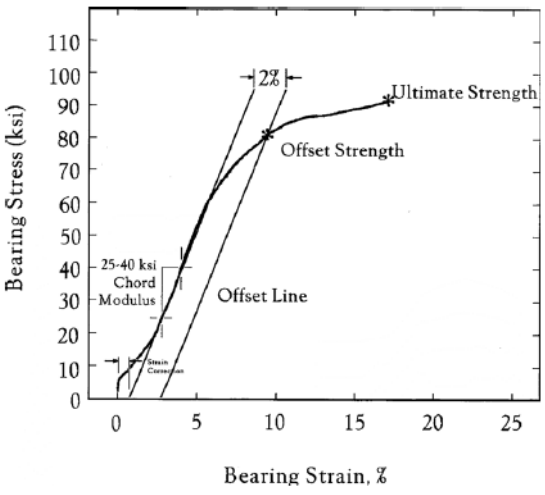

Fig. 2: Offset Bearing Stress construction [1].

Specimens were tested on TIRA 2300 machine (20 kN dynamometer) with displacement 2 mm/min and extensometer. Two sets of specimens were prepared and both bearing strengths from standard [1] were evaluated.

2 Results and Conclusions

In Tab. 1 results of the first set of specimens can be seen. Specimens with cylindrical insert cannot be evaluated because of different type then bearing failure. Second set of specimens were tested in different way (different clamping to the testing machine). Geometry of inserts is shown in Fig. 3 and 4. Both methods of clamping is shown in Fig. 5 and 6. Results from the second set can be seen in Tab. 2. From the measured values can be seen that specimens from the first set show higher average bearing strength with lower standard deviation then specimens from second set. Different configuration of experiments used during the testing of specimens from second set is better for obtaining right failure mode (right and wrong failure mode can be seen in Fig. 6 and 7). Evaluation of bearing stress can be seen in Fig. 8. Obtained results will be discussed with manufacturer and used for FE simulation of the real part manufactured with pellets (part of aircraft door construction, part of external fixator).

Tab. 1: Results from the first set of specimens.

Specimen No.	Offset bearing strength [MPa]	Initial bearing strength [MPa]
1_115_G_1	267,8	309,0
1_70_G_1	312,2	312,2
1_70_G_3	306,3	314,9
1_115_G_3	316,4	318,0
Average value	**300,7 ± 19,3**	**313,5 ± 3,3**

Tab. 2: Results from the second set of specimens.

Specimen No.	Offset bearing strength [MPa]	Initial bearing strength [MPa]
2_C_1	-	256,1
2_G_1	190,0	224,0
2_G_2	250,1	266,2
2_G_3	180,6	222,5
Average value	**206,9 ± 30,8**	**242,2 ± 19,3**

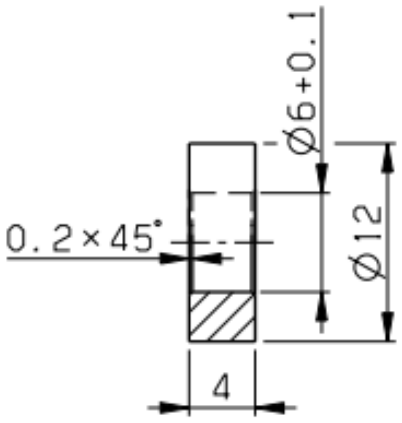

Fig. 3: Geometry of cylindrical insert.

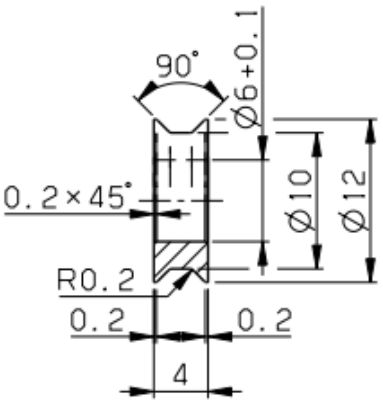

Fig. 4: Geometry of cylindrical insert with groove

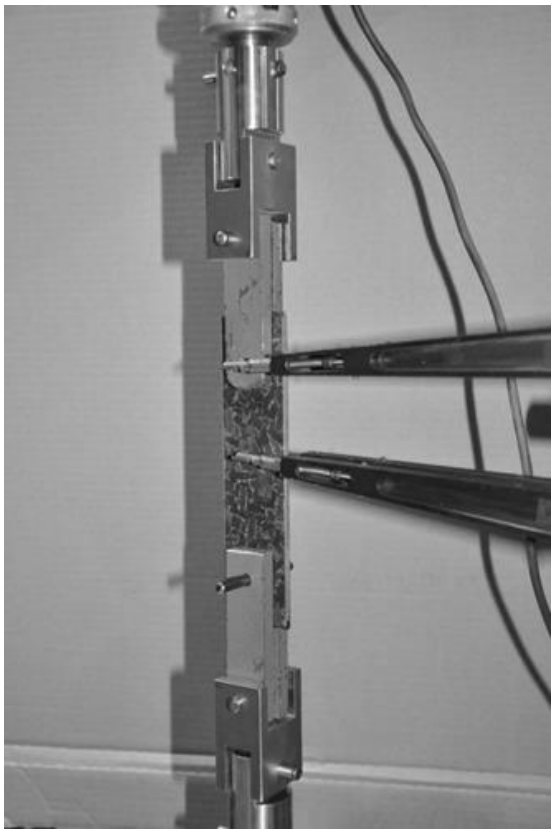

Fig. 4: Clamping of specimens from 1st set.

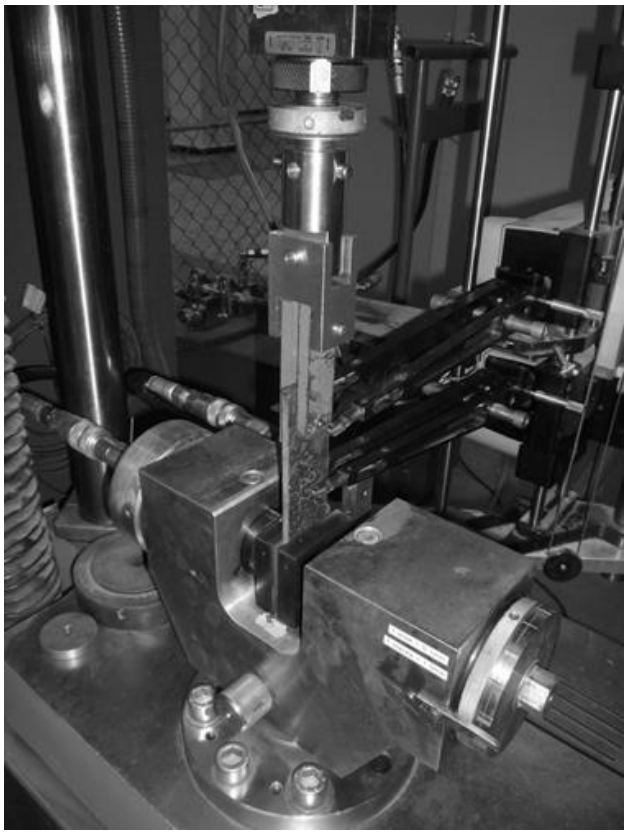

Fig. 5: Clamping of specimens from 2nd set.

Fig. 6: Right failure mode for bearing stress evaluation.

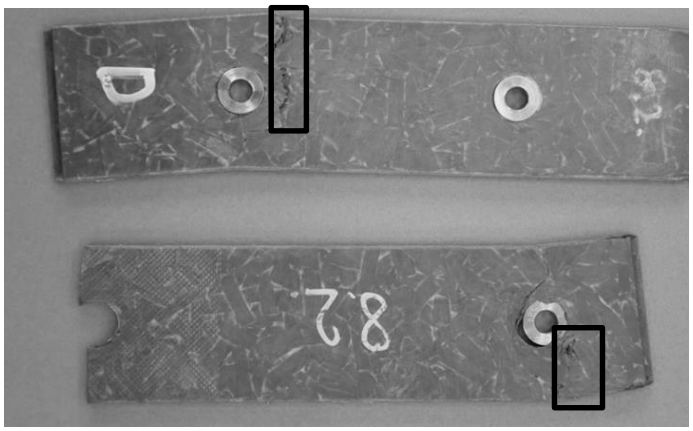

Fig. 7: Wrong failure mode.

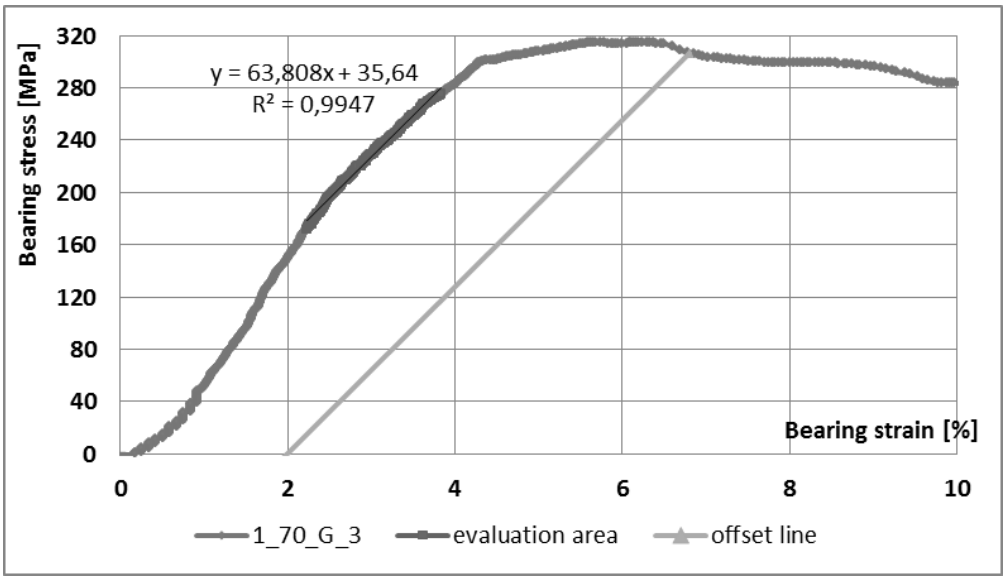

Fig. 8: Evaluation of bearing stress on 1_70_G_3 specimen.

Acknowledgement

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